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## 28th Annual Session

AMERICAN CONGRESS OF PHYSICAL MEDICINE

August 28, 29, 30, 31, September 1, 1950

HOTEL STATLER BOSTON

VOLUME XXXI JULY, 1950 NO. 7

# American Congress of Physical Medicine

28th Annual

# Scientific and Clinical Session

and

Instruction Seminar

August 28, 29, 30, 31, Sept. 1, 1950

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**August 28, 29, 30 and 31, 1950**

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### SCHEDULE

**Physicians only may enroll for letter series**

| | | |
|---|---|---|
| **MONDAY MORNING — AUGUST 28** | | |
| (A) 10:00-10:50 A.M. Neuro-anatomy of the brain and spinal cord Parlor B Corbin | (B) 11:00-11:50 A.M. Neuro-anatomy of the brain and spinal cord Parlor B Corbin | |
| **MONDAY AFTERNOON — AUGUST 28** | | |
| (C) 3:00-3:50 P.M. Pathologic physiology of lesions of the brain (types and localizations producing motor disturbances) Parlor B Karnosh | (D) 4:00-4:50 P.M. Pathologic physiology of lesions of the spinal cord (localization of lesions, including poliomyelitis) Parlor B Karnosh | |
| **TUESDAY MORNING — AUGUST 29** | | |
| (E) 8:30-9:20 A.M. Pathologic physiology of peripheral nerve lesions, including the neuritides Parlor B De Lorme | (F) 9:30-10:20 A.M. The physiologic effects of heat Parlor B Bierman | |
| **WEDNESDAY MORNING — AUGUST 30** | | |
| (G) 8:30-9:20 A.M. Technic of medical writing Parlor B Hammond | (H) 9:30-10:20 A.M. Technic of medical writing Parlor B Hammond | |
| **THURSDAY MORNING — AUGUST 31** | | |
| (J) 8:30-9:20 A.M. Physics of muscular action Parlor B Lion | (K) 9:30-10:20 A.M. Physics of muscular action Parlor B Lion | |

**Physicians and registered physical and occupational therapists may enroll for numbered series**

| | | |
|---|---|---|
| **MONDAY MORNING — AUGUST 28** | | |
| (1) 10:00-10:50 A.M. Recent hormonal investigations in rheumatoid arthritis Parlor C Polley | (2) 11:00-11:50 A.M. Recent hormonal investigations in rheumatoid arthritis Parlor C Polley | |
| **MONDAY AFTERNOON — AUGUST 28** | | |
| (3) 3:00-3:50 P.M. Physical Medicine in rheumatoid arthritis, in the light of the new treatment Parlor C Clark | (4) 4:00-4:50 P.M. The clinical use and dangers of microwave Parlor C Rae | |
| **TUESDAY MORNING — AUGUST 29** | | |
| (5) 8:30-9:20 A.M. Analysis of pathologic gaits, and gait training Parlor C Deaver | (6) 9:30-10:20 A.M. Resistive exercises in treatment of poliomyelitis Parlor C Schram | |
| **WEDNESDAY MORNING — AUGUST 30** | | |
| (7) 8:30-9:20 A.M. Useful mechanical devices used in Physical Medicine and Rehabilitation Parlor C Russek | (8) 9:30-10:20 A.M. Exercise in the treatment of asthma Parlor C Baker | |
| **THURSDAY MORNING — AUGUST 31** | | |
| (9) 8:30-9:20 A.M. Indications for orthopedic reconstruction in poliomyelitis Parlor C Green | (10) 9:30-10:20 A.M. Disabilities of the shoulder Parlor C Kottke | |

*Note: The Committee on Education of the American Congress of Physical Medicine is in charge of the instruction seminar. It is purposely planned to limit the subjects in any year to a few topics in order to devote enough time to those subjects to give those attending a good review, both from the standpoint of basic knowledge and from the clinical standpoint. Certain groups of these subjects will be repeated every three to five years.*

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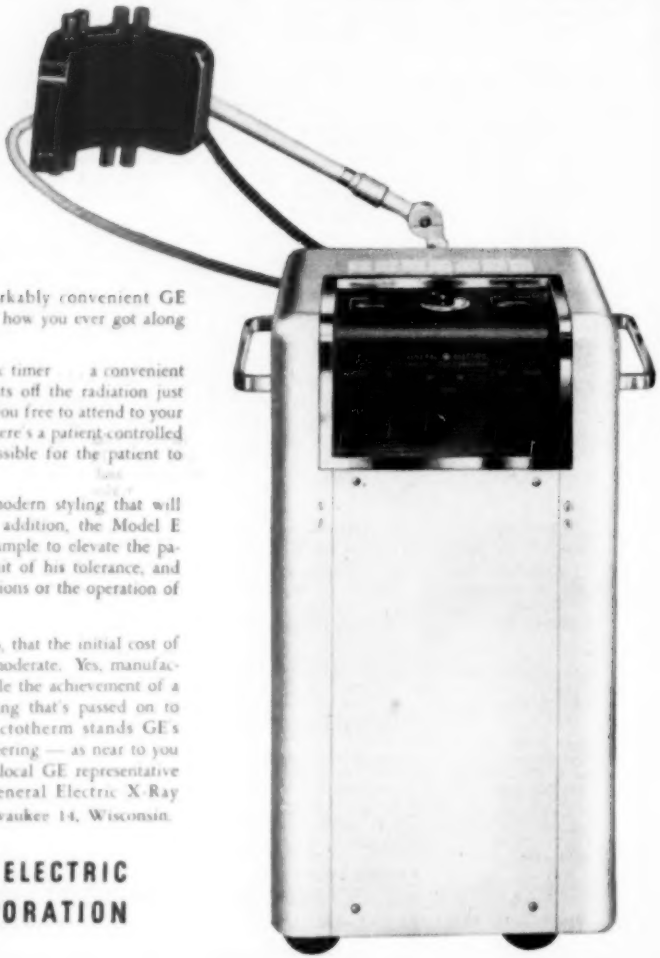

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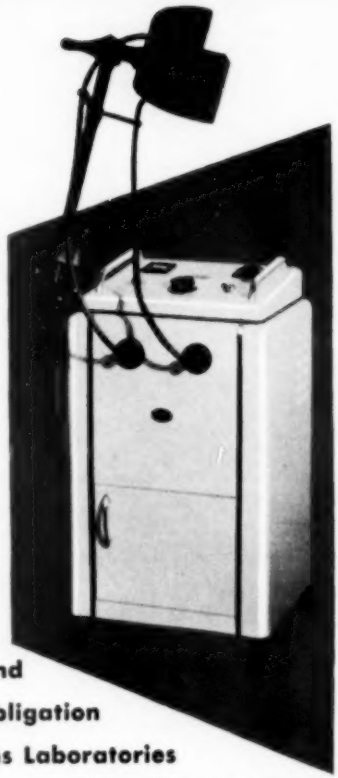

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# THE POTASSIUM PERMEABILITY AND THE CAPACITY FOR POTASSIUM STORAGE OF NORMAL AND ATROPHIED MUSCLE, INVESTIGATED WITH THE RADIOACTIVE ISOTOPE $K^{42}$ *

ERNST FISCHER, M.D.
JOHN W. MOORE, Ph.D.
HELEN V. SKOWLUND, M.S.
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and
N. JANE COPENHAVER

RICHMOND, VA.

During denervation atrophy the potassium content of the true muscle space — that is, muscle volume corrected for relative increase of nonmuscular tissue — increases at first slightly[1] and then decreases to values distinctly lower than for the normal control muscle.[2] It is generally recognized that the potassium concentration in normal muscle is about twenty-five times higher than in the plasma and that the muscle membrane is rather permeable for potassium.[3] The various proposed mechanisms which might enable the muscle to take up potassium against such a concentration gradient have been discussed in detail by Dean.[4] However, none of the proposed theories have become generally accepted. One of the main difficulties arises from the contradictory facts that, on the one hand, one is forced to assume all muscular potassium as ionized in order to account for the osmotic pressure, while, on the other hand, many experimental results indicate that some of the potassium in the muscle is present in an indiffusible state.[5] There is, as yet, no agreement about the ratio between diffusible and so-called bound potassium. Apparently the values reported for this ratio depend on the method of separation, since there exists probably no true bound potassium, but some of the potassium is immobilized to a varying degree with no sharp separation into fractions. It is generally assumed that whenever a fraction of potassium is "bound" the latter is associated with the muscular protein, especially with the myosin.[3] According to Neuschloss and Trelles,[5a] the bound fraction increases after denervation.

The use of radioactive potassium ($K^{42}$) should enable one, at least theoretically, to measure the potassium permeability of the muscle separately from the potassium storage capacity and to analyze how far the changes in potassium content observed in atrophy are due to altered permeability and/or

* From the Department of Physiology, Medical College of Virginia.
* This project of the Baruch Center of Physical Medicine was performed partly under contract between the Office of Naval Research and the Medical College of Virginia.
* Read at the Twenty-Seventh Annual Session of the American Congress of Physical Medicine, Cincinnati, Sept. 9, 1949.

1. Fenn, W. O.: Loss of Potassium in Voluntary Contraction, Am. J. Physiol. **120**:675, 1937.
2. Fischer, E.: Potassium in Denervated, Treated and Nontreated Muscle, Arch. Phys. Med. **30**:375, 1949.
3. Fenn, W. O.: Electrolytes in Muscles, Physiol. Rev. **16**:450, 1936.
4. Dean, R. B.: Theories of Electrolyte Equilibrium in Muscle, Biol. Symp. **3**:331, 1941.
5. (*a*) Neuschloss, S. M., and Trelles, R. A.: Ueber die Bedeutung des K-Ions für den Tonus des quergestreiften Muskels: I. Ueber die Menge und Bindungsweise des Kaliums in quergestreiften Muskeln unter normalen und pathologischen Bedingungen, Arch. f. d. ges. Physiol. **204**:274, 1924. (*b*) Ernst, E., and Mozocz, E.: Gebundenes Kalium Muskel, Enzymologia **9**:127, 1940. (*c*) Stone, D., and Shapiro, S.: Investigations of Free and Bound Potassium in Rat Brain and Muscle, Am. J. Physiol. **155**:141, 1948.

altered storage capacity. If the diminished potassium content of the atrophied muscle is due only to diminished capacity for taking up potassium against the concentration gradient, the time course of the $K^{42}$ exchange should be more or less the same for denervated and normal muscle (both muscles reaching two thirds $\left[1-\frac{1}{e}\right]$ of their final exchanges at about the same time). If permeability alterations alone are of importance, the muscle with higher permeability should reach two-thirds of its final exchange much quicker than the muscle with lower permeability. Furthermore, by separating the muscle potassium into a freely diffusible and a "bound" fraction, a much lower exchange should be found for the latter.

$K^{42}$ has been employed previously for such problems. However, only cyclotron potassium, with its relatively low specific activity, has been used. In consequence, in all these experiments, the amounts of potassium injected was many-fold the amount of potassium in the plasma of the animals and could be used, therefore, only for subcutaneous and intraperitoneal injection but not for intravascular injection. Since it is well known that a large fraction of any excess potassium is taken up by the muscles,[3] an interpretation of the results as an expression of potassium exchange alone might be doubtful.

Fenn and co-workers[6] reported that after injection of $K^{42}$ (rats and rabbits) the $K^{42}$ content of the rat muscle increases for four hours and then remains constant, whereas rabbit muscle reaches the constant level only after twenty-four hours. According to this group of workers, all muscle potassium is exchangeable with radioactive $K^{42}$. Hevesy and Hahn[7] found for the same animals that the $K^{42}$ exchange reaches constant level after twenty-four hours but that only a little more than half the muscle potassium is exchangeable. Fenn[6c] explained the lower exchange observed by Hevesy and Hahn by their use of $K^{42}$ material with a very light contamination with radioactive sodium ($Na^{24}$), which increases plasma activity in their experiments. Lyman[8] observed in rats two to nine minutes after intraperitoneal injection of $K^{42}$ that muscle denervated from two to thirty-one days contained on the average twice as much radioactive potassium as the normal control muscle. Lyman attempted to avoid altered blood supply of the denervated muscles by cutting the nerve inside the spinal cord and concluded that membrane permeability is increased after denervation. He reported, furthermore, but for only 2 animals, that after four hours the denervated muscles had only 82 per cent of the activity of the normal control muscle. In this work $K^{42}$ activity was determined, however, in extracts of frozen muscles after protein precipitation and not on whole muscle or on its digest. Unfortunately, some of Lyman's denervated muscles showed weight losses not at all comparable to those reported by others[9] for rat muscles denervated by the conventional method and for the same length of time.

6. (a) Nooman, T. R.; Fenn, W. O., and Haege, L.: The Effects of Denervation and of Stimulation on Exchange of Radioactive Potassium in Muscle, Am. J. Physiol. **132**:612, 1941. (b) Nooman, T. R.; Fenn, W. O., and Haege, L.: The Distribution of Injected Radioactive Potassium in Rats, Am. J. Physiol. **132**:674, 1941. (c) Fenn, W. O.; Nooman, T. R.; Mullins, L. J., and Haege, L.: The Exchange of Radioactive Potassium with Body Potassium, Am. J. Physiol. **135**:149, 1942.

7. (a) Hevesy, G., and Hahn, L.: Exchange of Cellular Potassium, K. danske vidensk. Selsk. biol. medd. **16**:5, 1941. (b) Hahn, L., and Hevesy, G.: Potassium Exchange in Stimulated Muscle, Acta physiol. skand. **2**:51, 1942.

8. Lyman, C. P.: Penetration of Radioactive Potassium in Denervated Muscle, Am. J. Physiol. **137**:392, 1942.

9. (a) Hines, H. M., and Knowlton, G. C.: Changes in the Skeletal Muscle of the Rat Following Denervation, Am. J. Physiol. **104**:279, 1933. (b) Knowlton, G. C., and Hines, H. M.: Kinetics of Muscle Atrophy in Different Species, Proc. Soc. Exper. Biol. & Med. **35**:194, 1936. (c) Fischer, E.: The Effect of Faradic and Galvanic Stimulation upon the Course of Atrophy in Denervated Skeletal Muscle, Am. J. Physiol. **127**:608, 1939.

## Procedure and Methods

All experiments were performed on white rabbits. The gastrocnemius-soleus muscles used were either normal or had been submitted for various lengths of time (up to twenty-four days) to aseptic nerve section or tenotomy. Some of the denervated muscles had been treated daily by appropriate electrical stimulation.[10]

At various times before killing, the animals received intravenous or intraperitoneal injections of a tracer dose of $K^{42}$ (7 to 50 microcuries per kilogram). Although we received the $K^{42}$ material from Oak Ridge National Laboratory with a specific activity of 10 to 15 microcuries per kilogram at arrival time, the activity at the time of injection was much less, owing to the short half-life of 12.4 hours for $K^{42}$ and the time delay caused by changing potassium carbonate powder received into a standardized neutral potassium chloride solution. Since $K^{42}$ material is shipped only once weekly and we could handle one animal at a time, the amount of potassium to be injected, with the desired activity, had to be varied between 1 and 100 mg. The maximal potassium doses tolerated intravenously at slow injection (three to five minutes) was about 7 mg. of potassium per kilogram, or approximately 40 per cent of the estimated total potassium content of the serum. Therefore, at injection time, the specific activity of the solutions for injection remained high enough for the intravenous route only for two to three days per shipment.

The potassium chloride solutions injected contained no sodium at all or only traces (flame photometer), less than 0.01 per cent of the potassium content. Any radiation of our solutions due to $Na^{24}$ could have been not more than 0.13 per cent of the total activity, since the neutron cross section in the atomic pile is apparently thirteen times as high for sodium as for potassium.[11] There was no difference between the results with absolutely sodium-free solutions and those in which traces of sodium were present.

The animals were killed from fifteen minutes to sixty hours after injection; blood was drawn immediately by heart puncture and serum separated by centrifuging. In some experiments the red cells were washed with saline solution, then hemolyzed with distilled water, radioactivity measured and potassium determined with a flame photometer.[12]

Both gastrocnemii were removed and weighed, and double samples of about 0.500 Gm. each were cut into small pieces and placed in shallow ashing dishes. After the activity was measured, the samples were digested with a 0.6 ml. concentrated nitric acid at room temperature for twenty hours. Finally, their potassium content was determined after appropriate dilution (flame photometer). In some of the experiments, samples of the liver were treated in the same way.

The rest of the gastrocnemii were cut with scissors to a thick paste and then extracted under stirring with three times the volume of distilled water for thirty minutes at room temperature. After centrifugation, a decanture was separated from the residue. Samples of the latter were treated like the muscle samples, while the activity of the decanture was measured and potassium determined directly after dilution. Extractable potassium was calculated in per cent of total potassium under the assumption, supported by preliminary experiments, that the residue (which represents 125 per cent of the weight of the original muscle) contains 62.5 per cent by volume of fluid comparable to the decanture.

From the radioactivity and the potassium content of residue and decanture, radioactivity and potassium content per gram of original muscle can be calculated. The value for muscles found with this indirect way checked, as a rule, within ±5 per cent of those determined directly on muscle samples. Only in experiments with animals killed less than four hours after injection, much larger differences occurred between direct and indirect determination of the activity but not of the potassium content. Since the difference between the activity of the two direct samples was much larger (up to 20 per cent) for experiments of short duration than for those of long duration (±5 per cent), the larger differences in the former must be attributed probably to difference in circulation between various parts of the same muscle. As will be seen from our results, circulation determines to a large extent the initial rate of exchange. In animals with both normal gastrocemii and short injection times, with the indirect method, no difference larger than 7 per cent observed for their counting rates, whereas occasionally

10. (*a*) Fischer, E., and Ramsey, V. W.: The Effect of Daily Electrical Stimulation of Normal and Denervated Muscles upon Their Protein Content and upon Some of the Physicochemical Properties of the Protein, Am. J. Physiol. **145**:582, 1946. (*b*) Fischer, E.; Skowlund, H. V.; Ryland, K. W., and Copenhaver, N. J.: Electrophoresis of the Water-Soluble Proteins of Normal and Atrophied Muscles, Nontreated and Treated by Daily Electrical Stimulation, to be published. (*c*) Footnotes 2 and 9c.

11. Catalog and Price List No. 3, United States Atomic Energy Commission, July 1949.

12. Berry, J. W.; Chappell, D. G., and Barnes, R. B.: Improved Method of Flame Photometry, Indust. & Engin. Chem., Analyt. Ed. **18**:19, 1946.

two samples of the same normal muscle showed 20 per cent difference. Therefore, for final evaluation, we used the values of the indirect method.

All samples were counted, if possible, after drying on a hot plate with a Tracerlab G-M tube (window less than 2.0 mg. per centimeter) and a Tracerlab Autoscaler. As a rule, for each sample the time for 4,096 counts was measured at least twice. The counting rate of most of the samples was fifty to one hundred times above the rather steady background. Only for the serum with its low potassium content was the counting rate lower, occasionally as low as ten times the background.

For all fluid or organs, the specific activity was calculated as counts per milligram of potassium at the time of injection. The exchange of $K^{42}$ is the specific activity of the organ or fluid expressed in per cent of the specific activity of the serum potassium.

## Results

*Normal Muscle.* — The $K^{42}$ exchanges observed for normal muscles of animals in which the $K^{42}$ has been injected intravenously are given in chart 1.

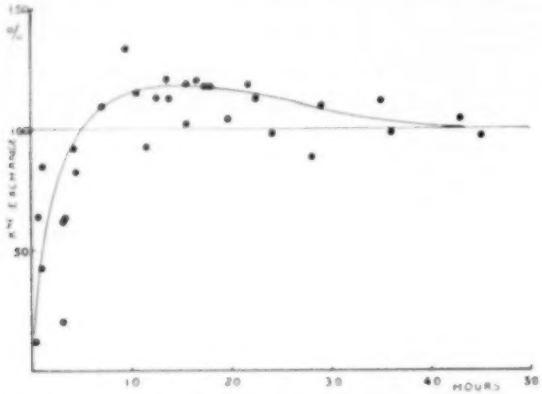


Chart 1. — $K^{42}$ exchange $= \frac{\text{specific activity of muscle K} \times 100}{\text{specific activity of serum K}}$ of normal muscle plotted against time in hours. Experiments with intravenous injection.

Although some variation from one animal to another is apparent, a curve expressing the general result can be easily drawn. With our method of exchange calculation, 100 per cent is reached after approximately five hours, and then the exchange still rises to a maximum of about 115 per cent, from which it drops slowly to 100 per cent. In contrast with this rather clear cut result, the $K^{42}$ exchanges observed in muscles of animals with intraperitoneal injections (chart 2) vary to a quite unusual extent, even for biological experiments. Despite the large number of individual experiments, any curve drawn to express the average behavior would be rather arbitrary and meaningless. For reasons to be discussed later in detail, the assumption is suggested that in some rabbits the muscles are blocked for a normal exchange by an unknown condition varying in its importance from animal to animal. In chart 2 a curve is drawn to demonstrate what can be regarded as "normal unblocked exchange," which reaches its maximum in about eighteen hours.

One of the first causes to be considered as an explanation for the low muscular exchange in some of the animals was the possibility that in these animals the absorption from the peritoneum was delayed or irregular. When the activity of the plasma, expressed in per cent of the injected activity, is plotted against time (chart 3 for intravenous and chart 4 for intraperitoneal

injections), this explanation loses plausibility. If one disregards the values for very short times elapsed after intraperitoneal injection, the plasma of the animals injected by this route contains a higher per cent of the injected activity than the plasma of the intravenously injected animals. For rather short

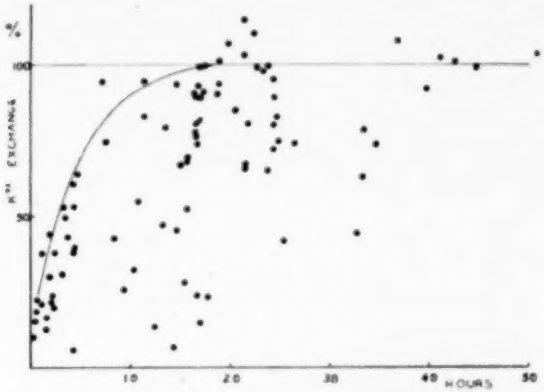


Chart 3. — $K^{42}$ exchange of normal muscle plotted against time in hours. Experiments with intraperitoneal injection.

times, the plasma of intraperitoneally injected animals shows small values, as one might expect from delayed absorption, but there are many short time experiments in which the plasma values are much higher than in experiments by the intravenous route. As a whole, higher values of plasma activity are

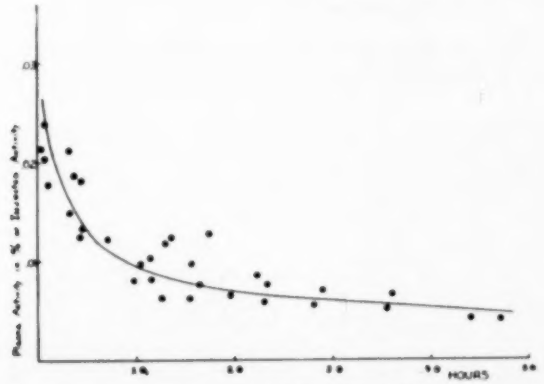


Chart 2. — Relative plasma activity $\frac{\text{activity of plasma} \times 100}{\text{injected activity per Kg.}}$ plotted against time in hours. Experiments with intravenous injection.

reached by intraperitoneal than by intravenous injection. It is well known that injected potassium disappears at an astonishingly quick rate from the plasma,[13] but our results show clearly that, whatever mechanism is responsible for the quick removal of excess potassium, this process is much quicker

13. Wilde, W. S.: The Distribution of Potassium in the Cat after Intravascular Injection, J. Biol. Chem. 128:309, 1939. Footnotes 6 and 7.

and more effective when the plasma potassium level is raised suddenly (intravenous injection) than when the potassium rise is relatively slow owing to the delay of absorption (intraperitoneal injection).

In an attempt to find the reason for the blocked muscular $K^{42}$ exchange as found in such a relatively large number of rabbits, the figures of the observed exchanges were examined to determine whether or not their variation shows any correlation with the potassium content of plasma or muscle, with age, weight or sex of the rabbits and with the specific activity or the absolute amount of the injected potassium. No correlation between the extent of blockage of the muscle for $K^{42}$ exchange and any of the mentioned variables could be demonstrated. However, a clear inverse correlation exists between the muscular $K^{42}$ exchange and the plasma activity expressed in per cent of the injected activity. The insert of chart 4 shows the correlation existing

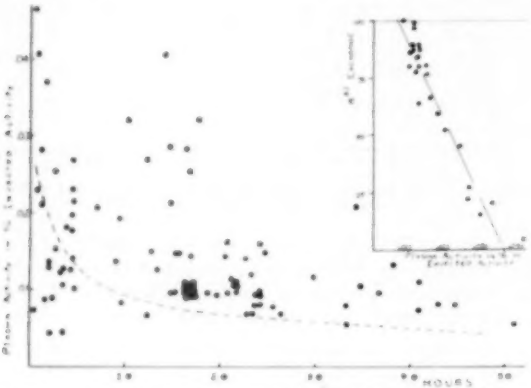

Chart 4. — Relative plasma activity plotted against time in hours. Experiments with intraperitoneal injection. Broken curve, relative plasma activity after intravenous injection. Insert: $K^{42}$ exchange of normal muscle (fourteen to eighteen hours after intraperitoneal injection) plotted against relative activity of plasma.

for animals killed fourteen to eighteen hours after intraperitoneal injection. Those animals, the muscles of which exchanged $K^{42}$ only poorly, have extremely high plasma activity. The same correlation was found for other groups of animals with comparable times elapsed after injection. Even for the whole group, this correlation is still obvious, if, in order to compensate for the different duration of the experiments, the observed $K^{42}$ exchange is expressed in per cent of "normal unblocked exchange" expected at that time after injection (curve in chart 2). Therefore, it is probably permissible to regard the low exchange of $K^{42}$ by the muscles as the reason for the high plasma activity. It is well known that the ingestion of potassium by the muscles is one of the main factors for the quick loss of excess potassium from the plasma.[11]

In some of our later experiments, we measured also the $K^{42}$ exchange for liver and red blood cells. There exists much less variability of $K^{42}$ exchange for erythrocytes and liver than for the muscles. The exchanges observed for blood cells and liver were of about the same magnitude and regularity as those reported by Fenn and co-workers,[6c] whose graphs show clearly the higher variability of the muscle exchanges. Similar comparison for animals with intravenous injection (chart 5) demonstrated that, although the variability of the muscle exchange is less than with the intraperitoneal route,

this variability is larger than that of the values for liver or red blood cells.

If one compares the exchanges for liver, red cells and muscle (chart 5) with the activity level of the plasma (chart 3), it becomes obvious that the quicker an organ exchanges $K^{42}$, the more overshooting of the 100 per cent exchange occurs. This is, as already suggested by Fenn[86] (for experiments with slow intravenous injection of radioactive potassium of low specific activity), apparently due to the fact that the organs reach equilibrium with the $K^{42}$ of the plasma rather early after injection but cannot release $K^{42}$ as quickly

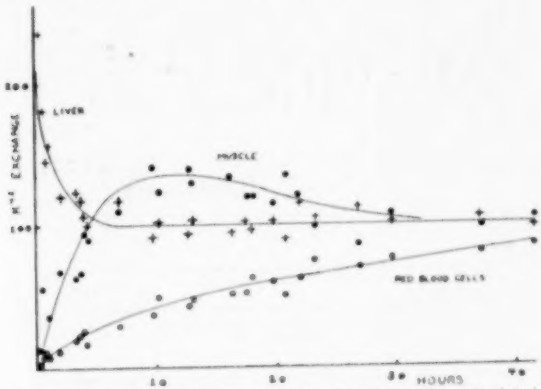


Chart 6. — $K^{42}$ exchange of liver, red blood cells and normal muscle plotted against time in hours. Experiments with intravenous injection.

as the plasma activity declines. This apparent overshooting must be larger for organs with quick exchange than for those with slow exchange, since the plasma activity declines exponentially, at first quickly and then much more slowly (chart 3).

*Diffusible and "Bound" Potassium.* — With the extraction method and the adopted method of calculation, 85.9 ±0.3 per cent (standard deviation ±2.3 per cent) of the total muscle potassium (on the average 4.27 mg. per gram of muscle) was found to be freely diffusible, and only the remainder (14.1 per cent) could be regarded as more or less bound in normal muscle.

The mean specific activity of the residue of normal muscles was only 85.5 ± 0.4 per cent (standard deviation ± 4.3 per cent) of the specific activity of the extract. The potassium content was, on the average, 1.132 mg. per gram for the residue and 1.035 mg. per milliliter for the extract. The average separation ratio between residue and extract was 1:2.2. The deviation of this ratio from the original ratio of one part muscle to three parts extraction fluid is due to the swelling of the muscle fragments during extraction. From these figures for relative activity of residue and extract, for their potassium content and for their separation ratio, one can calculate that only about 5.1 per cent of the total muscle potassium did not participate in $K^{42}$ exchange of normal muscle.

These mean values were derived from all experiments without attention to the time elapsed after injection or to the route of injection. Detailed statistical analysis of the data showed that neither the time elapsed since injection nor the route of administration influences the "relative activity of the residue."

*Denervated Muscle.* — Since normal muscles vary so much from animal to animal in their $K^{42}$ exchange, a much more erratic behavior could be expected

when denervated muscles are compared with their normal control muscles. Although this is true to a certain extent, it is relatively easy to explain some of the variations. Chart 6 represents the $K^{42}$ exchange of the denervated

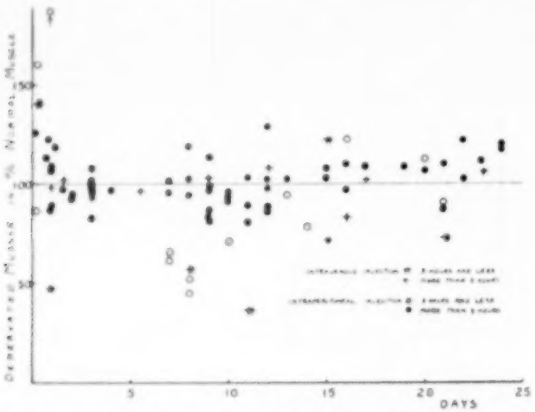


Chart 6. — $K^{42}$ exchange of denervated muscle, expressed in per cent of the exchange of the normal control muscle, plotted against duration of denervation in days.

muscles, expressed in per cent of the exchange of their normal control muscles, plotted against the time elapsed since denervation. If one regards only the values for experiments lasting more than three hours, it is obvious that the duration of the denervation does not affect the results. The $K^{42}$ exchange for the denervated muscle can be both lower and higher than that of the control muscle (as a rule, within ± 20 per cent) but the mean value calculated shows no statistically significant difference to that of normal muscle. In experiments in which the animal was killed early, the observed exchange, which represents the initial $K^{42}$ exchange, is distinctly diminished for muscle denervated for more than three days. For more or less acutely denervated muscles (up to three days), the initial exchange of the denervated muscle is, as a rule, distinctly higher than for the normal muscle.

The question arises immediately whether the final $K^{42}$ exchange of the denervated muscle, when expressed as per cent of the normal control muscle, does not depend on the exchange reached by the latter, which, as shown before, is often less than expected because of the unknown "blocking process." In chart 7 the $K^{42}$ exchange in the denervated muscles, again expressed as per cent of the exchange of the normal control muscle, is plotted against the exchange of the latter, measured as per cent of the expected "normal unblocked exchange" (curve in chart 2). As a rule, the denervated muscle has a higher exchange than the normal as long as the $K^{42}$ exchange of the latter is less than about 93 per cent of "expected unblocked exchange." As soon as the normal muscle has about 100 per cent exchange or more, the tendency is rather obvious that the final exchange is lower for the denervated muscle than for the normal muscle. Apparently the blocking process affects denervated muscles less than normal ones, but if the muscle potassium is not blocked denervation diminishes the final exchange value.

With our extraction method, no significant difference of diffusible potassium, expressed as per cent of total potassium, between denervated and normal muscle could be detected. However, the ratio formed by the relative

activity of the residue of the denervated muscle (specific activity of residue expressed as per cent of the specific activity of the extract) to the relative activity of the residue of the normal control muscle had the tendency to increase with time since denervation: from 0.99 on the first to the fourth day of denervation to 1.02 on the eighth to the tenth day and to 1.05 on the

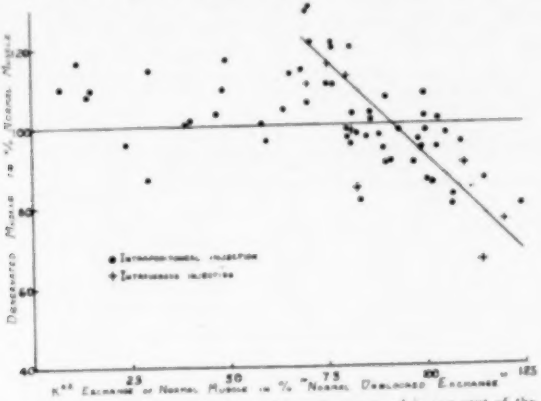


Chart 7. — $K^{42}$ exchange of denervated muscle, expressed in per cent of the exchange of the normal control muscle, plotted against the exchange of the latter expressed in per cent of the "expected unblocked exchange" (see text).

fourteenth to the twenty-fourth day. All the experiments have been lumped for this calculation into only three groups to get relatively large series for statistical analyses. The differences of the mean values for relative activity of the residue are significant on the 5 per cent level between the middle group and the first or the last group, and the difference between the first and the last group is highly significant on the 1 per cent level. Therefore, these experiments indicate the tendency that, with progressing denervation atrophy, the small fraction of potassium which does not participate in $K^{42}$ exchange decreases somewhat.

*Denervated Muscles Treated by Daily Electrical Stimulation.* — When treated denervated muscles were compared with nontreated denervated controls, it was obvious that treatment retarded atrophy and increased potassium content, as reported previously,[2] and that distinct changes in the early

TABLE I. — *Mean Values for Two Groups of Animals with Both Gastrocnemii Denervated, One Treated Daily.**

| No. of Experiments | Time After Injection | Weight | Total K | $K^{42}$ Exchange | Extract K | Relative Activity of Residue |
|---|---|---|---|---|---|---|
| 3 | 20′ — 3h25′ | 150.1 | 122.2 | 109.2 | 99.4 | 98 |
| 4 | 4h15′ — 4h30′ | 148.8 | 120.1 | 63.9 | 97.6 | 95 |
| 8 | 12h50′ — 38h15′ | 151.3 | 123.3 | 99.1 | 100.6 | 97 |

* The average duration of denervation for the three groups is 15 days, 15.2 days and 15.4 days, respectively. All values are for the treated muscle expressed in per cent of the corresponding values for the untreated muscle.

$K^{42}$ exchange rate were brought about by the treatment (table 1). At the start (up to about three hours) the exchange rate is increased and then distinctly diminished, but the same final exchange is reached.

Extractable potassium is not influenced by the treatment but the decrease in relative activity of the residue, if statistically analyzed, is significant

on the 5 per cent level. If one disregards the initial rise of $K^{42}$ exchange rate, which might be due to circulation increase,[14] treatment of the muscle further decreases the exchange rate already decreased by denervation. The increase by treatment of the potassium fraction, which does not exchange with $K^{42}$, is a reversal of the denervation effect.

*Atrophy Due to Tenotomy.* — The changes in $K^{42}$ exchange during atrophy due to tenotomy were much more regular than those observed during denervation atrophy. Tenotomy increased $K^{42}$ exchange without a single exception, but the increase of the initial rate is much more pronounced than the increase in final exchange (table 2).

TABLE 2. — *Mean Values for Four Groups of Animals with One Gastrocnemius Tenotomied and with Normal Control Muscle.**

| No. of Experiments | Days After Tenotomy | Time After Injection | Weight | Total K | $K^{42}$ Exchange | Extract K | Relative Activity of Residue |
|---|---|---|---|---|---|---|---|
| 4 | 8.3 | 20′ — 2h30′ | 85.2 | 85.2 | 144.5 | 99.6 | 1.02 |
| 5 | 9.1 | 2h45′ — 5h00′ | 86.7 | 87.7 | 123.8 | 101.1 | 1.01 |
| 6 | 8.6 | 15h00′ — 18h00′ | 89.6 | 87.7 | 112.1 | 98.7 | 1.00 |
| 5 | 8.5 | 23h00′ — 42h00′ | 87.5 | 86.3 | 110.3 | 100.6 | .98 |

* All values for the tenotomied muscle expressed in per cent of the corresponding values for the normal control muscle.

The small differences found for extractable potassium and for the potassium fraction not participating in the $K^{42}$ exchange are statistically without significance.

As reported elsewhere,[10b] denervation performed simultaneously with tenotomy prevents the tenotomy contracture and, in consequence, diminishes weight loss and the deterioration of certain muscle proteins as seen after tenotomy alone. Similar experiments were performed concerning potassium content and $K^{42}$ exchange and revealed that simultaneous denervation diminishes the potassium loss due to tenotomy and also decreases the raised $K^{42}$ exchange (table 3). The small differences observed for extractable potassium and for the relative activity of residue are statistically without significance.

TABLE 3. — *Mean Values for a Group of Animals with One Gastrocnemius Tenotomied and Denervated, the Control Muscle Only Tenotomied.**

| No. of Experiments | Time After Operation | Time After Injection | Weight | Total K | $K^{42}$ Exchange | Extract K | Relative Activity of Residue |
|---|---|---|---|---|---|---|---|
| 6 | 7 to 9 days | 13h30′ — 32h00′ | 109.6 | 113.6 | 93.2 | 100.9 | 0.99 |

* All values for the tenotomied and denervated muscles are expressed in per cent of the corresponding values for the tenotomied control muscle.

## Comment

The data presented in this paper for the $K^{42}$ exchange of normal muscle reveal that the low penetration for $K^{42}$ found by Hevesy and Hahn[7] was not necessarily caused by a contamination with $Na^{24}$, as suggested by Fenn.[6c] In our experiments the same $K^{42}$ solutions caused in one rabbit 100 per cent or more final exchange and in another only a relatively small exchange. This high variability of the results escaped the previous investigators, since they were restricted by the scarcity of $K^{42}$ at that time to the use of only a few animals. It is of interest that Fenn[6c] commented on the fact that Hevesy

14. (a) Vanotti, A., and Magiday, M.: Untersuchungen zum Studium des Trainiertseins: V. Mitt. Ueber die Capillarisierung der trainierten Muskellatur, Arbeitsphysiol. 7:618, 1934. (b) Wakim, K. G.; Terrier, J. C.; Elkins, E. C., and Krusen, F. H.: Effects of Percutaneous Stimulation on the Circulation in Normal and in Paralyzed Lower Extremities, Am. J. Physiol. 153:183, 1948.

and Hahn's rabbits had much higher relative plasma activity (expressed in per cent of injected activity) than his own animals. This is now best explained by the negative correlation between "relative plasma activity" and final $K^{42}$ exchange level of the muscles (chart 4). Although our experiments gave no indication as to what conditions determine the extent of blockage of the muscle for $K^{42}$, there exists the possibility that genetic and dietary factors are responsible for the different mean exchange values found by Fenn and Hevesy, respectively.

Theoretically, many factors could produce such large differences in the $K^{42}$ penetration. For human erythrocyte in vitro, Levi[15] demonstrated that $K^{42}$ penetration is considerably reduced by the presence of calcium ions in physiologic concentrations. It is of interest that even in $K^{42}$ experiments with muscle fibers in vitro (tissue cultures of chick embryo muscle), extremely high variations of exchange rate occur.[16] In experiments with isolated frog skin, the permeability for $Na^{24}$ showed large variation from skin to skin under constant conditions, and permeability of each skin was rather sensitive to changes in the $p$H of the solution.[17] That denervation of a muscle tends to decrease the potassium blockage of the muscle does not mean necessarily a direct nervous influence upon potassium permeability.

In recent years the viewpoint has been expressed that the potassium within the cell is not in equilibrium between diffusion force and a potassium-holding force but that a "steady state" exists.[18] The cell continually expends energy in order to transport potassium to replace that lost by outward diffusion. The rather quick penetration by $K^{42}$ and its slower loss, which results in the "overshooting" of the $K^{42}$ concentration so distinct for liver and muscle, does not speak in favor of a potassium transport by energy expenditure. Ursing,[19] on account of $Na^{24}$ experiments on muscle, rejected Krogh's suggestion of an actively maintained steady state and suggested a possible membrane model which would explain an exchange of ions between two phases at different concentrations without consumption of chemical energy.

It should be recalled here that in some of the experiments the potassium content of the plasma was raised only 5 to 6 per cent by the intravenous injection. Thus, any mechanism of quick removal of excess potassium,[20] cannot have interfered seriously, and the results must be attributed to $K^{42}$ exchange alone. The finding that, even in our experiments of short duration, only about 5 per cent of the total muscle potassium does not participate in the $K^{42}$ exchange, demonstrates the small importance of immobilization of potassium ions inside the cells. The existence of this small fraction of nonexchangeable potassium has not been considered in our calculation of $K^{42}$ exchange. A 100 per cent $K^{42}$ exchange calculated for muscle potassium is, in reality, a 105.3 per cent exchange. It is regrettable that, owing to the large variation from muscle to muscle, an exact curve of exchange rate could not be established, which would permit, as originally planned, mathematical analyses of the relation between $K^{42}$ gradient and the rate and direction of $K^{42}$ transport.

15. Levi, H.: Note on the Permeability of Red Blood Corpuscles to Potassium, Kgl. Danske Videnskabernes Selskab Mat.-Fysiske Medd. **23**:10, 1945.
16. Wesson, W. G., Jr.; Cohn, W. E., and Brues, A. M.: The Effect of Temperature on Potassium Equilibria in Chick Embryo Muscle, J. Gen. Physiol. **32**:511, 1949.
17. Ursing, H. H.: The Active Ion Transport Through the Isolated Frog Skin in the Light of Tracer Studies, Acta physiol. skan. **17**:1, 1949. Transport of Ions Across Cellular Membranes, Physiol. Rev. **29**:137, 1949.
18. Krogh, A.: The Active and Passive Exchange of Inorganic Ions Through the Surface of Living Cells and Through Living Membranes Generally, Proc. Roy. Soc. London, B **133**:140, 1946. Hahl, P. M.; Tulin, M.; Danowski, T. S.; Lavietes, P. H., and Peters, J. P.: The Distribution of Sodium and Potassium in Oxygenated Human Blood and Their Effects upon Movements of Water Between Cells and Plasma, Am. J. Physiol. **149**:249, 1947.
19. Ursing, H. M.: Interpretation of the Exchange of Radio-Sodium in Isolated Muscle, Nature, London **160**:262, 1947.
20. Footnotes 6c and 13.

An evaluation of the experiments on denervated muscle is handicapped by our restricted knowledge of the circulatory changes in denervated muscle. There is probably no doubt that the initial increase in exchange rate of acutely denervated muscle is due to increased circulation.[6a] Hines and co-workers[21] measured with a bubble-flow meter blood flow in denervated hindlimbs of dogs and found a distinct increase (241 to 144 per cent of the control limb) twelve hours after denervation; no change according to the mean value (151 to 64 per cent) after three to twenty-one days, and for twenty-seven to fifty-two days some decrease in circulation (96 to 59 per cent). For rabbits no experimental figures are known. Since the denervation changes are slower in rabbits than in dogs,[22] one may assume that for our chronically denervated muscle (up to twenty-four days) no important change in circulation existed. The more or less constant decrease observed in initial rate of $K^{42}$ exchange suggests a decreased potassium permeability. However, since the final exchange is lower in denervated muscle provided the control muscles are not blocked (chart 7), one might assume that the equilibrium or steady state for intracellular potassium is lowered and, therefore, the initial exchange decreased. The fact that potassium content in the true muscle phase is distinctly lowered by denervation[2] supports this explanation. The decrease of the potassium fraction, which does not participate in $K^{42}$ exchange, is rather small and unimportant, but does not support Neuschloss' findings of marked increase of bound potassium.

The only clear cut result of the experiments with the treated denervated muscle is the reversal of the denervation decrease in the nonexchangeable potassium. The very early increase of the initial exchange rate could be explained by increased circulation of the exercised muscle.[14] However, the decrease immediately following in the exchange rate, despite equal final exchange and increased intramuscular potassium concentration, cannot be explained at the moment, if one does not want to assume a further decrease of the membrane permeability already lowered by denervation. The number of experiments was rather small, but, owing to the fact that there was (by chance?) very little variation between the experiments of each group, all the possible differences between the three figures for $K^{42}$ exchange were proved as rather significant by statistical analyses (on the 2 per cent and 1 per cent level).

The experiments with tenotomied muscles confirm the findings reported elsewhere[10b] that initially tenotomy damages the muscles more than denervation and that simultaneous denervation diminishes the early deterioration of the tenotomied muscle, probably owing to the prevention of the tenotomy contracture. The increased initial rate of exchange in tenotomied muscle is probably due to increased circulation in consequence of the contracture. Even after twenty-four hours the $K^{42}$ exchange is higher than in the normal muscle despite the lower potassium content of the tenotomied muscle; this might be an indication that tenotomy increases somewhat the membrane permeability.

## Summary

Radioactive potassium ($K^{42}$) of high specific activity was injected intravenously or intraperitoneally into rabbits with one gastrocnemius-soleus muscle denervated at various times previously. After intravenous injection the normal muscle reaches, more or less regularly, 100 per cent $K^{42}$ exchange

21. Kemp, C. R.; Tuttle, W. W., and Hines, H. M.: Studies on the Temperature Characteristics, Blood Flow and Activity in Normal and Denervated Hind Limbs of the Dog, Am. J. Physiol. **150**:703, 1947.
22. Knowlton, G. C., and Hines, H. M.: Kinetics of Muscle Atrophy in Different Species, Proc. Soc. Exper. Biol. & Med. **35**:594, 1936.

after approximately five hours, and then the exchange continues to rise to a maximum of about 115 per cent, dropping slowly to 100 per cent thereafter. After intraperitoneal injection, the $K^{42}$ exchanges vary greatly from animal to animal, some few reaching 100 per cent in eighteen to twenty hours, but many have a much smaller exchange even after more than thirty hours. For reasons discussed in detail, it is assumed that there exists a blocking mechanism which prevents muscular $K^{42}$ exchange to a varying extent. About 5 per cent of the total muscular potassium may not participate in a free $K^{42}$ exchange.

Acutely denervated muscles have an increased initial $K^{42}$ exchange rate, probably owing to increased circulation, while the initial exchange rate of muscle denervated for four days and more is decreased. The final exchange of denervated muscle depends on the extent of blockage of the $K^{42}$ exchange for normal muscle. If the normal muscle has a low exchange, the denervated has a higher exchange, since denervation apparently diminishes the blockage mechanism. However, if the normal muscle has a high $K^{42}$ exchange, the denervated muscle has a distinctly lower exchange. Since the total muscle potassium is also diminished, the results are interpreted as a decrease of the equilibrium level or of the steady state necessary for maintenance of the intramuscular potassium concentration. Nonexchangeable potassium is decreased slightly by denervation.

Comparing denervated muscles treated daily by appropriate electrical stimulation with the nontreated control muscles revealed an initially increased $K^{42}$ exchange rate, probably due to increased circulation of the exercised muscle. Later, after four hours, the exchange has dropped considerably under the values for the control, although the final $K^{42}$ exchange is the same. The intramuscular potassium concentration is considerably increased. Treatment reverses the denervation decrease in the nonexchangeable potassium.

In tenotomied muscle the initial exchange is considerably increased, probably because of increased circulation. The final exchange is higher than in the normal control, despite the decreased muscular potassium concentration, which suggests increased membrane permeability. The changes observed in muscle tenotomied for seven to nine days are more marked than those in muscle denervated for the same length of time. Simultaneous denervation, which prevents the development of contracture, diminishes weight loss as well as the decrease in muscular potassium concentration and the elevation of the $K^{42}$ exchange.

# STUDIES IN CUTANEOUS ADRENERGIC BLOCKADE *

## An Application of Ion Transfer

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CHICAGO

Clinical conditions in which vasospasm plays a dominant role constitute a significant part of the practice of physical medicine. Arteriosclerosis obliterans, causalgia, scleroderma, early Buerger's disease and chronic nonspecific indolent ulcers are a few of the commoner states that can be benefited by pharmacologic blockade of the sympathetic nervous system.

Because of the toxicity of Dibenamine[1] (N-[2-chlorethy] dibenzylamine chloride) when administered parenterally, it was suggested that this systemic toxicity might be circumvented if the drug were introduced into the skin by ion transfer.

Before any trial of the drug was attempted on human patients the effect of the blocking drugs on the depilated skins of albino rabbits was studied.[2] In addition to Dibenamine, studies were carried out on SY-28 (N-[2-bromoethy]-N-ethyl-l-napthalene-methylamine hydrobromide) introduced by Loew and Micetich.[3]

This preliminary study on rabbits convinced us that it was safe to apply these drugs by ion transfer to human beings. In the present study only persons with normal skins were tested.

### Method

Orthopedic patients having no involvement of the arms were selected for testing.[4] The solution containing the adrenergic blocking agent was administered by ion transfer to the medial and volar aspects of the right forearm in all subjects. Simultaneously, a control solution containing the agent alone (without current) was applied to the medial aspect of the left forearm. The solvent plus current was applied to the lateral aspect of the left forearm.

The solvent used for both drugs was propylene glycol. The solutions were freshly prepared prior to each experiment. Previous tests showed that although propylene glycol is essentially nonconducting, solutions containing the dissolved agent conducted a current moderately well.

The concentration of SY-28 was held constant at 10 mg. per cubic centimeter of propylene glycol, whereas Dibenamine was used at a concentration of 50 mg. per cubic centimeter. The active electrodes consisted of rectangular strips of asbestos paper 5.0 by 1.5 cm. completely saturated with 0.4 cc. of the test solution. Since the active ion carried the positive charge, the positive pole was applied to the active elec-

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* Read at the Twenty-Seventh Annual Session of the American Congress of Physical Medicine, Cincinnati, Sept. 9, 1949.

1. Nickerson, M., and Goodman, L. S.: Federation Proc. 5:194, 1946; J. Pharmacol. & Exper. Therap. 89:167, 1947.
2. Last, J. H.; Rodriquez, A. A., and Pitesky, I.: Abstracted in Federation Proc. 8:313, 1949.
3. Loew, E. R., and Micetich, A.: Federation Proc. 6:304, 1947.
4. These patients were made available to us through the courtesy of Dr. F. A. Chandler and the orthopaedic staff of the University of Illinois Research and Educational Hospitals.

trode. The current density was maintained throughout at 0.33 milliamperes per square centimeter of active electrode.

To measure the adrenergic blocking activity, epinephrine hydrochloride was injected intradermally into all three treated sites and into an untreated skin area. Determination of suitable concentrations of epinephrine was made by testing 29 normal subjects with varying concentrations (of epinephrine). As a result of this preliminary study, it was decided to use three dilutions of epinephrine: 1:375,000 as a concentration which produced good vasoconstriction in all the subjects tested; 1:1,500,000 as a threshold concentration, which produced some moderate or faint vasoconstriction in all subjects tested, and 1:3,000,000 as the concentration to which 50 per cent of normal subjects showed some degree of vasoconstriction. Each patient was tested for his response to all three dilutions at each test site.

The order of concentration of epinephrine which was injected into the tested sites was alternated in the various subjects so that the most concentrated was injected proximally in one subject and in the next the least concentrated was injected proximally. With these dilutions vasoconstriction reached its maximum in about fifteen minutes and persisted well over thirty minutes after injection. The amount of vasoconstriction obtained was noted and recorded at fifteen and thirty minute intervals after injection.

Two diameters of the blanched skin were measured and the areas computed. These areas were then weighted for intensity of vasoconstriction. This was done by arbitrarily recognizing four degrees of vasoconstriction and assigning an intensity number for each degree. Thus, the amount of vasoconstriction was described as full (and therefore no blocking), faint (partial blocking), very faint (considerable blocking) and none (or complete blocking). The numbers 3, 2, 1 and 0, respectively, were assigned. The area multiplied by the intensity factor yielded a weighted area of vasoconstriction. The percentage of blocking was then easily obtained mathematically by comparing the treated sites with the control sites.

*Experiments with SY-28.* — The amount of drug introduced into the skin depends upon the ampere hours and the electrochemical equivalent of the drug. Since the amperes in this study and the electrochemical equivalent were constant, dosage could be considered to be directly proportional to the time of administration.[5] Accordingly, the duration of application was varied from two to eight minutes in an attempt to determine the minimal effective therapeutic dosage.

The first 20 subjects treated with SY-28 were tested with epinephrine one-half hour after the application was begun. These preliminary experiments revealed two significant facts: first, that SY-28 is a potent adrenergic blocking agent, capable of blocking for at least one-half hour each of the concentrations of epinephrine, and, second, that it has sensitizing properties.[6] After the observation of the sensitizing properties of SY-28, it was of interest to determine whether the sensitization reaction interfered with the adrenergic blocking activity. Since the sensitization reaction in a treated skin site was maximum at twenty-four hours following ion transfer it was at this time that adrenergic blocking activity would also have to be noted. Thus, in an additional series of 53 subjects, control data on adrenergic blocking activity were gathered twenty-four hours after ion transfer with SY-28.

At the time of application of the agent a patch test was applied, usually over the scapular area. This was observed for two days and then discarded. Those who showed negative reactions were patch tested at weekly intervals for three weeks when possible and the results recorded. Those with positive reactions were, whenever possible, again subjected to the identical ion transfer procedure as at first. The responses after sensitization were then compared with those before sensitization.

In order to evaluate histamine blocking activity, 0.01 cc. of 1:100,000 histamine phosphate was administered intradermally into treated and control skin sites, and the resultant whealing and flare was evaluated in the same manner as described for the response to epinephrine.

5. Osborne, S. L., and Holmquest, H. F.: Technic of Electrotherapy and Its Physical and Physiological Basis, Springfield, Ill. Charles C Thomas, Publisher, 1944, p. 65.
6. Rodriquez, A. A.; Last, J. H., and Rostenberg, Jr., A.: Federation Proc. 8:339, 1949.

*Experiments with Dibenamine.* — Dibenamine was applied for periods ranging from twenty to thirty minutes. Patch tests were applied to 10 subjects in exactly the same manner as described for SY-28.

## Results

*Experiments with SY-28.* — Cutaneous Epinephrine-Blocking Activity Thirty Minutes After Ion Transfer: Blocking of 1:3,000,000 epinephrine injected intradermally was complete at the three minute dosage level in 6 subjects. Five out of six subjects showed 100 per cent blocking of 1:1,500,000 epinephrine at the three minute level. Two subjects showed 100 per cent blocking of all concentrations of epinephrine at the five minute dosage level.

TABLE 1. — *Ion Transfer of SY-28.*

| Concentration of Epinephrine | No. of Subjects | SY-28 Dosage Time, Minutes | Mean Percentage Blocking | |
|---|---|---|---|---|
| | | | Per Cent | Standard Deviation |
| 1:375,000 | 4 | 2–3 | 20 | 41 |
| | 10 | 4 | 51 | 42 |
| | 10 | 5 | 82 | 23 |
| | 9 | 6 | 73 | 32 |
| | 10 | 7 | 50 | 41 |
| | 10 | 8 | 79 | 38 |
| 1:1,500,000 | 4 | 2–3 | 62 | 43 |
| | 9 | 4 | 75 | 42 |
| | 9 | 5 | 90 | 22 |
| | 8 | 6 | 72 | 36 |
| | 10 | 7 | 81 | 31 |
| | 10 | 8 | 92 | 25 |
| 1:3,000,000 | 4 | 2–3 | 75 | 50 |
| | 10 | 4 | 90 | 24 |
| | 7 | 5 | 83 | 33 |
| | 8 | 6 | 79 | 39 |
| | 10 | 7 | 99 | 4 |
| | 10 | 8 | 97 | 10 |

SY-28 did not diffuse through the skin when applied without current in sufficient concentrations to show any blocking activity. There was no evidence of any adrenergic blocking activity in any of the control sites.

Cutaneous Epinephrine-Blocking Activity Lasting Twenty-Four Hours After Ion Transfer: In 53 patients subjected to periods of application of the ion transfer procedure varying from two to eight minutes in duration and

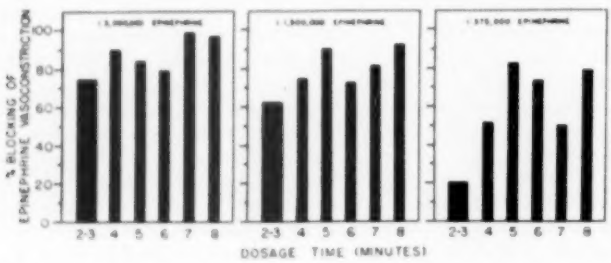


Fig. 1. — Cutaneous adrenergic blocking action of SY-28 administered by ion transfer.

tested twenty-four hours later with epinephrine an effective blocking action was noted. Table 1 presents a summary of this data. The huge standard deviations reflect the variability in responses found in different subjects. Figure 1 shows the blocking activity of SY-28 for the different dosages employed.

Sensitization to SY-28: Fifty-eight subjects were tested for sensitization. Twelve of these were lost from observation. Of the remaining 46 subjects, 12, or 26 per cent, showed an eczematous sensitization. This figure may be low, for half of these subjects could be followed only one or two weeks.

Effect of Sensitization on the Pharmacologic Activity of SY-28: Seven of the sensitized patients resubjected to the same ion transfer procedure as at first demonstrated clearly that the participation of SY-28 in the sensitization reaction did not interfere with its ability to block epinephrine (table 2).

TABLE 2. — *Effect of the Sensitization Reaction on the Adrenergic Blocking Activity of SY-28.*

| Concentration of Epinephrine | No. of Subjects | Dosage Time, Minutes | Mean Percentage Blocking — Before Sensitization | Mean Percentage Blocking — After Sensitization |
|---|---|---|---|---|
| | 2 | 2 | 91 | 96 |
| | 1 | 3 | 100 | 100 |
| 1:375,000 | 1 | 4 | 20 | 100 |
| | 1 | 5 | 95 | 100 |
| | 2 | 6 | 34 | 100 |
| | 2 | 2 | 100 | 100 |
| | 1 | 3 | 100 | 100 |
| 1:1,500,000 | 1 | 4 | 0 | 100 |
| | 1 | 5 | 100 | 100 |
| | 2 | 6 | 28 | 100 |
| | 2 | 2 | 100 | 100 |
| | 1 | 4 | 100 | 100 |
| 1:3,000,000 | 1 | 5 | 100 | 100 |
| | 2 | 6 | 50 | 100 |

On the contrary, some patients showed some increase or apparent enhancement of the adrenergic blocking action of SY-28 (fig. 2). Furthermore, of

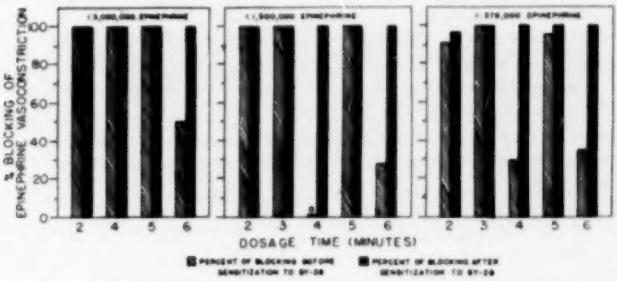


Fig. 2. — Effect of the sensitization reaction on the adrenergic blocking activity of SY-28.

6 patients tested with histamine before and after sensitization, none exhibited any impairment of the histamine-blocking action of the drug.

Cutaneous Histamine-Blocking Action Twenty-Four Hours After Ion Transfer: The average percentage twenty-four hour blocking of the wheal effect of 1:100,000 histamine, administered iontradermally, was found to be 83 per cent at the five minute dosage level and 54 per cent at the four minute level. Again, wide variability in individual response was found (table 3), but the antihistaminic activity of SY-28 when administered by ion transfer was clearly exhibited.

*Experiments with Dibenamine.* — Duration of Cutaneous Epinephrine Blocking: A total of 40 subjects were treated for twenty to thirty minutes

TABLE 3. — *24 Hour Cutaneous Histamine* Blocking Action of SY-28 Administered by Ion Transfer.*

| Number of Subjects | SY-28† Dosage Time in Minutes | Degree of 24 Hour Blocking | | | |
|---|---|---|---|---|---|
| | | Wheal Effect | | Vasodilation Effect | |
| | | Per Cent | Standard Deviation | Per Cent | Standard Deviation |
| 2 | 3 | 0 | 0 | 73 | 1 |
| 8 | 4 | 54 | 43 | 66 | 39 |
| 7 | 5 | 83 | 27 | 90 | 11 |

* Used in dilution of 1:100,000.
† Used in dilution of 10 mg. per cubic centimeter of propylene glycol.

with the test solution of Dibenamine Hydrochloride. The vasoconstricting effect of epinephrine was satisfactorily blocked for at least one-half hour in 27 subjects. The mean percentage blocking ranged from 68 to 80 per cent for 1:375,000 epinephrine and from 79 to 85 per cent for 1:1,500,000 epinephrine. Again, there was considerable variation in response (table 4). For

TABLE 4. — *Ion Transfer of Dibenamine Blocking of the Vasoconstriction Produced by Intradermally Administered Epinephrine.*

| No. of Subjects | Dosage Time, Minutes | Mean Percentage Blocking of Epinephrine 1:375,000 | Standard Deviation | Mean Percentage Blocking of Epinephrine 1:1,500,000 | Standard Deviation |
|---|---|---|---|---|---|
| | | ½ Hour Blocking Action | | | |
| 13 | 20 | 80 | 22 | 85 | 29 |
| 13 | 25 | 68 | 33 | 79 | 36 |
| 1 | 30 | 70 | — | 100 | — |
| | | 2 Hour Blocking Action | | | |
| 3 | 30 | 67 | 58 | 67 | 58 |
| | | 4½ Hour Blocking Action | | | |
| 10 | 30 | 14 | 22 | 18 | 24 |

example, in the responses to 1:1,500,000 epinephrine, 15 out of 27 subjects showed 100 per cent blocking response and 9 showed varying degrees of blocking, whereas 3 showed no blocking whatever.

In no instance did the site where the control solution containing Dibenamine was applied without current show any detectable blocking. The same was true for the site where the current was applied to the solvent alone.

Three subjects were tested two hours after the ion transfer application and a mean percentage blocking action of 67 per cent was noted for both concentrations of epinephrine (2 showed 100 per cent blocking and 1 showed none whatsoever).

Ten subjects were tested four and one-half hours after application and exhibited a mean percentage blocking of only 14 per cent for 1:375,000 epinephrine and 18 per cent for 1:1,500,000. In the latter test 5 out of the 10 showed no blocking activity whatever and the most effective blocking was 54 per cent in 1 subject.

Testing for Sensitization: Ten subjects were patch tested in exactly the same manner as described for SY-28. No evidence of sensitization was noted in this group.

## Comment and Summary

SY-28 exhibited very potent local adrenergic blocking activity lasting twenty-four hours, when administered by ion transfer. The duration of application necessary to obtain effective blocking ranged from four to eight minutes. Unfortunately, the high incidence of sensitization (26 per cent in a series of 46 subjects) when the drug was administered by ion transfer precludes its usefulness as a therapeutic agent by this technic. It was of interest that, while participating in the eczematous sensitization reaction, SY-28 was

still capable of adrenergic blocking activity. Antihistaminic activity was also clearly exhibited.

Transient local adrenergic blocking activity was exhibited by Dibenamine Hydrochloride when administered by ion transfer. Twenty to thirty minutes of the ion transfer is required to produce 68 to 80 per cent blocking of epinephrine for a period of one-half to two hours after application of the drug. After two hours, however, blocking activity rapidly declined. Further studies on this phase of the problem are in progress. No sensitization to Dibenamine was noted in 10 subjects tested.

## Discussion on Papers of Dr. Rodriquez and Others and Dr. Fischer and Others

**Dr. Irvin F. Hummon** (Chicago): It is interesting to note the gradual change in the type of papers that we have been getting at the Congress in the last twenty years. It used to be that our papers were more on a clinical basis, based upon impressions and opinions pertaining to clinical experience; then we began to attract young men with a background of physiology and pharmacology, who found in physical medicine a place to use their fundamental knowledge in clinical practice. These men are trained in the scientific method, in which some experimental procedure is formulated to test or answer the problems, controlled experiments are done and the results analyzed.

These two papers are excellent examples of this type of investigation. Clinicians without a background in the present status of these problems may find papers such as these difficult to follow and to place in their proper perspective. However, we know that it is upon investigations such as these that physical medicine has attained its present stature and upon which its future will depend.

The papers of Dr. Rodriquez and his coworkers presents another example of the administration of drugs by ion transfer. Drugs administered in this manner must be active at very low concentration, which is true of both the drugs investigated.

Of the two, SY-28 is the more interesting, as it is active in very small concentrations. The fact that it has both the stimulating contraction effect of epinephrine and the paralyzing relaxation effect of histamine makes it a very interesting type of drug. Lowe and his coworkers were unable to show this histamine blocking action by oral or intravenous administration. Therefore it may be assumed that the local concentration obtained by ion transfer was higher than that obtained by the other routes. The site of action of these drugs must be directly upon the receptive or responsive mechanism of the muscle or of muscle fibers.

I should like to ask Dr. Rodriquez what happened to the skin under the electrode before the tests were done with epinephrine or histamine. Was there any visible effect on the skin itself?

Another interesting point was the fact that the action of SY-28 was very long, lasting for twenty-four hours or more. This is not usual with medicaments given by ion transfer, as most of the drugs that are administered in that way have within the body some form of neutralizing material, which is apparently not present for these particular drugs.

It is unfortunate that there is the sensitization effect; otherwise, a very interesting drug would be available for use. The action of Dibenamine being similar but without the sensitization effect, may be available.

The second paper, by Dr. Fischer and his coworkers, is part of the continuing study on the potassium phase in muscle metabolism and contraction. It is an excellent example of the use of radioactive isotopes in research, illustrating their possible use to answer questions which would be very difficult or perhaps impossible to answer in any other way. These workers have shown that the ionizable potassium and the so-called bound potassium are present in a relatively constant ratio, at least in normal muscle. They have found the presence of the peculiar blocking action to potassium diffusion and have shown also the relation of potassium permeability to normal denervated muscle.

The fact that the electrical stimulation of denervated muscle tended to keep the findings nearer to those of normal muscle is another factor to add to our knowledge that electrical stimulation aids in maintaining tone of denervated muscle.

I hope that the authors of the papers will continue their investigations and that at some later period they will give us other papers, summing up their findings and the possible clinical applications of these findings.

**Dr. Arthur Rodriquez** (closing): The skin under the electrode (containing the agent) revealed a distinct erythema which was more intense than the erythema which would have been present due to the passage of current alone. It also lasted far longer, frequently being visible more than twenty-four hours later.

# THE THIMBLE ELECTRODE *

## A Device for the Rapid Localization of Motor Points

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and

S. J. SARNOFF, M.D.

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Ever since Robert Remak wrote his detailed description of motor points,[1] localized external electrical stimulation has been used for the purpose of activating muscle in man. Remak showed that these selected external points are either on or near the site of entrance of the various motor nerves into the muscle or at some rapidly palpated proximal anatomic structure.

In the past the procedure of motor point stimulation has consisted in exploration with a metal electrode, or, in the case of the phrenic motor point, digital palpation followed by removal of the palpating finger and substitution of the electrode to the previously located spot.

It is possible to produce consistently effective artificial respiration by means of the intermittent electrical stimulation over the motor point of the phrenic nerve.[2] Since it is implicit in any successful method of resuscitation that it should be capable of initiating respiration promptly, considerable attention was given to developing a technic which would achieve the most rapid localization of the phrenic motor point. The application of this technic to the general problem of motor point stimulation is the subject of this communication.

It was found that if, instead of attempting to locate the motor point with the nonsensitive pen or rod type electrode, the stimulating electrode was worn as a thimble directly on the tip of the palpating finger, much more rapid localization was obtained. Not only were intermediate steps eliminated, but the delicacy required for finding the motor point was more readily achieved when the electrode became a part of the sensitive exploring finger. It was also easier to maintain contact with the motor point.

Figure 1 shows the thimble electrode. It consists of vinylite constructed in the form of a long flexible thimble to fit the index finger fairly snugly. The posterior aspect is a single sheet of vinylite. The anterior aspect is a double sheet between which the cloth-covered wire end is secured at the finger tip. The lead wire is sealed in the lateral edge of the thimble. This lead wire is 12 inches long and provided with an attachment by which it is connected to the source of current.

Figure 2 shows localization of the phrenic motor point and the contraction of the diaphragm. If the right nerve is stimulated, the electrophrenic respirator is placed at the left so that the operator can conveniently adjust the voltage while exploring for the phrenic motor point.

A large, standard type dispersive electrode is applied to some convenient skin area, such as the upper part of the back.

In each of 24 successive subjects it was found possible to localize the

* From the Department of Physiology, Harvard School of Public Health.

1. Remak, R.: Observationes anatomicae et microscopicae de systematis nervosi structura, Berlin, Reimer, 1838.

2. Sarnoff, S. J.; Maloney, J. V. Jr.; Sarnoff, L. C.; Ferris, B. G., Jr., and Whittenberger, J. L.: Management of Respiratory Irregularities in Acute Bulbar Poliomyelitis by Means of Electrophrenic Respiration, to be published. Sarnoff, S. J.; Whittenberger, J. L., and Sarnoff, L. C.: Electrophrenic Respiration. VII. Motor Point of the Phrenic Nerve, to be published.

phrenic motor point rapidly and to initiate effective respiration. The shortest "explore" time was two seconds, the longest forty-five seconds (ten seconds on second attempt). The average explore time was 7.3 seconds. In 87 per cent the motor point was stimulated in ten seconds or less.

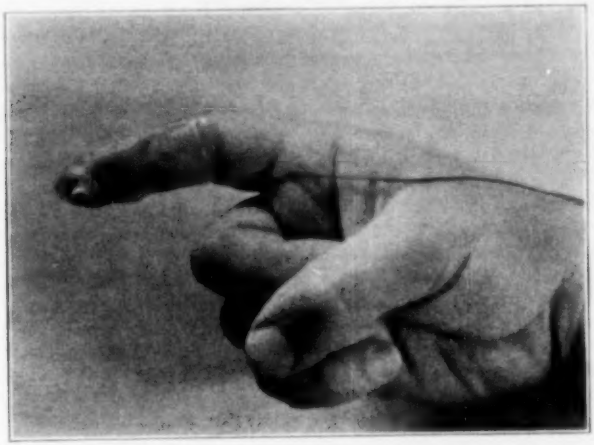

Fig. 1. — Thimble electrode. Note the cloth-covered metal tip. The finger is insulated from the electrode by a lining sheet of vinylite.

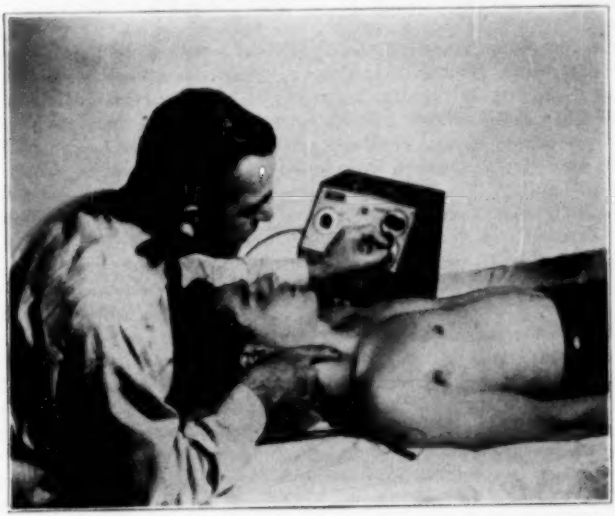

Fig. 2. — Right-sided electrophrenic respiration. The exploring finger, covered by the thimble electrode, faces posteriorly while displacing the sternocleidomastoid medially. In this position the electrode tip is separated from the phrenic nerve only by skin and platysma if firm contact is made with the ridge of the anterior scalene.

## Summary

The consistency and rapidity of motor point localization was found to be greatly improved by a new device, which provides for the incorporation of a stimulating electrode in a flexible plastic thimble worn on the index finger.

# THE SWANNANOA PLAN FOR THE REHABILITATION OF TUBERCULOUS VETERANS *

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There are certain diseases for which there is as yet no exact yardstick with which to measure the extent of their resulting disabilities. Tuberculosis is one of the more important examples. The factors involved are so numerous and diversified that no single test can furnish adequate and valid criteria by which the degree of disability in any individual patient can be determined. Many attempts have been made in the past to evaluate the disability resulting from tuberculosis by various tests. One of the most widely used is the walking test which is outlined in Diagnostic Standards published by the National Tuberculosis Association; in that, in order to reach the clinical status of "arrested," a patient must have engaged in supervised walking exercise or its equivalent one hour twice a day for the last two months prior to discharge. This walking test, while it is a yardstick of measurement, is certainly not accurate. The terrain, walking conditions and climatic conditions, all will affect the amount of physical demands inherent in a given task. It is also certainly not specific in helping patients to measure their individual capacity realistically, for it is obvious that certain patients will engage in less actual walking after discharge than was required of them during the last few months of hospitalization while others may require much more.

Numerous efforts have been made to devise a more realistic test than simple walking exercise. A number of institutions and organizations have set forth to test physical capacity or physical tolerance for exercise required in the normal living of tuberculous patients. Probably the largest and most comprehensive program was started by the Veterans Administration in the early part of 1947 at what is now the Swannanoa Division of the Oteen Veterans Administration Hospital at Oteen, N. C. Its scope was considerably larger than the plans other organizations have previously tried. It was, however, a matter of trial and error in many respects.[1]

The object of this testing program was to attempt more nearly to approximate the normal living day in the hospital of a patient with tuberculosis to what may be planned after discharge. In other words, we plan to fit our program in the hospital to the patient and his needs upon discharge—not to try to fit the patient to the program. In an effort to do this a number of different diversified activities were set up. These included photography, carpentry, wood work, plastics, light metal, light mechanics, jewelry repair, radio and electrical repair, graphic arts, watch repair and other similar fields, as well as a full range of educational subjects.

The patients are admitted to the center at the time that their disease is classified as quiescent by National Tuberculosis Diagnostic Standards. However, they must have no evidence of cavitation, and their sputum must have been negative for acid-fast bacilli for at least four to six months prior to admission.

* Read at the Twenty-Seventh Annual Session of the American Congress of Physical Medicine, Cincinnati, Sept. 7, 1949.

[1] Sponsored by the Veterans Administration and published with the approval of the Chief Medical Director. The statements and conclusions published by the author are the result of his own study and do not necessarily reflect the opinion or policy of the Veterans Administration.

1. Bobrowitz, I. D.: Rehabilitation of the Tuberculous, Am. Rev. Tuberc. 55:42 (Jan.) 1947. Oppikofer, K.: The Appisberg Occupational Healing Centre for Tuberculous Convalescents, Occup. Therapy 26:431 (Dec.) 1947. Siltzbach, L. E.: Clinical Evaluation of the Rehabilitation of the Tuberculous, National Tuberculosis Association, 1944.

They should be physically able to engage in certain rehabilitation activities and, of course, should have a desire to be benefited by our program.

As originally planned, the patients were supposed to have stayed in the hospital for a period of four months. This was to allow a gradual increase of the periods of activity in the rehabilitation program up to six hours a day. This plan has been in effect now for approximately two and one-half years, and more than 900 patients have been treated at this center. Originally, no effort was to be made to force the patient to participate in the treatment program. However, we have found that for a patient simply to do nothing was neither testing his capacity nor benefiting him for his posthospitalization activity. Therefore, it is now the policy of this rehabilitation center that each patient admitted will participate in a specific program of rehabilitation activities, just as much as he does in any other form of tuberculosis therapy—such as pneumothorax, bed rest and others.

It is surprising, indeed, that we have had extremely few patients who objected to this activity. In the past two and one-half years that we have had the center, approximately 87 per cent of the patients who entered the program have completed it and stayed until their disease has reached the status of "full arrest." The A. W. O. L. and disciplinary discharge rate has been low: 2.5 and 3.5 per cent respectively. There were no discharges against medical advice; however, an additional 7 per cent of the patients left voluntarily under the provisions of the Veterans Administration Technical Bulletin 10A-132, which states that a patient who has reached a quiescent status of his tuberculosis may, if his home conditions are suitable, request and be granted discharge to his own care.

It is interesting to note that the patients in the center have all cooperated fully in attempting to follow the program. They all apparently realize that we are attempting to bring about a reduction in reactivation of the disease and subsequent readmission to a tuberculosis hospital. This is, of course, the basic objective of any tuberculosis rehabilitation program.

In a study of 104 consecutive patients discharged from the rehabilitation center for the period of May 1, through Sept. 30, 1947, which I have previously discussed,[2] it was found that we had a ratio of minimal, moderately advanced and far advanced disease of 1:2:1. Ninety patients stayed in the hospital until a diagnosis of arrested disease was made, whereas 14 left early.

A follow-up was made in 1949 in which all of the 104 discharged patients were contacted. At the time of the follow-up study, all the patients had been discharged at least eighteen months and some over two years. The following interesting information was obtained: One patient died from illness other than tuberculosis; 1 patient was killed in an automobile accident; 2 patients developed extrapulmonary tuberculous lesions which they had not previously had, and 20 patients suffered reactivation of a pulmonary tuberculosis lesion. Of these 20 patients, 2 had never had any previous parenchymal pulmonary lesions—just a simple pleurisy. Two of these, both Negroes, are reported to have subsequently died of pulmonary tuberculosis.

Comparing the 20 who broke down with the group which remained well, the following facts were disclosed: Sixty-five per cent of the total group received collapse therapy. The same percentage of those whose disease became reactivated had received collapse therapy. Significant also was the fact that the total number of white patients outnumbered the Negro 2 to 1, but of the patients who broke down only 11 were white whereas 9 were Negro. The average stay in the center for the total group was 111.5 days. The average stay in the center of those who broke down was 89 days. One of these patients stayed 224 days. If he were eliminated, the average stay of the other 19 was less than 80 days.

2. Bagby, B. B., Jr.: Rehabilitation of the Tuberculous Veteran, Nat. Tuberc. A., 1948.

The ratio of minimal, moderately advanced and far advanced was the same for the total group as it was for the group that broke down.

At the time of discharge, 14 of the patients left before they completed their program. Ninety stayed their full time. Comparing these two groups we found that 28.5 per cent of those who left early have already broken down whereas of the full term group only 18.7 per cent have had reactivation. Also, only 28.5 per cent of the early group are now working and well. In striking contrast, 66.6 per cent of the full term group are working and still well. There were only 19 patients of the 104 who are well but not working. Of these, 6, or 31.5 per cent, left the center before the full program was completed. Four others of the 19 have worked since discharge but were not working at the time of the follow-up study.

It is evident from these figures that some of these patients could have benefited probably by a longer period of rehabilitation. It is also probably true that some of the patients did not need quite so long a time in the center as they were required to stay. These variable factors and influences have made our program here one of great interest and have necessitated making individualization of each patient and each patient's program and care in the center a vital one.

Experience has shown us that we cannot standardize the procedure but that every patient requires a carefully "hand-tailored" program for his complete recovery and to assure him that he will stay well.

## Summary

During the two and one-half years in which the Rehabilitation Center, Swannanoa Division, Oteen Veterans Administration Hospital, Oteen, N. C., has been in existence, several factors have become evident.

The first and most important is that most patients will recognize the benefits of such a program and will stay in the hospital to receive the full benefit of treatment.

Second, those few patients who do leave before treatment is completed have a much higher rate of reactivation than those patients who attain an "arrest" of their disease before discharge.

Third, Negro patients have a higher incidence of reactivation than the white patients. The cause of this higher incidence is not entirely clear and demands further investigation.

Fourth, an unusually large number of patients who have completed the program were able to direct themselves to gainful employment almost immediately after discharge and were able to continue working, with a low rate of reactivation.

The discussion of this paper will appear in a later issue of the ARCHIVES.

# THE EFFECT OF MICROWAVES ON BONE AND BONE MARROW AND ON ADJACENT TISSUES *

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When radar became available for peacetime application, studies of its possibilities in the field of medicine along some of the lines used previously for high frequency currents of longer wavelengths were started. It has been demonstrated[1] that microwave diathermy causes an increase in tissue temperature and an increase in the blood flow.[2] When compared with short-wave diathermy in studies on animals,[3] the differences between the temperatures produced in deep tissues by the microtherm director "A" and those produced by some short wave generators were not significant. It has also been reported[4] that microwaves, being a potent therapeutic agent, may be dangerous because of their greater penetration.

Since some of the effects of conventional and short wave diathermy on bone have been reported,[5] it was considered appropriate to investigate the effects of microwaves on bone and bone marrow. The purpose of this study was to determine the temperature relationships produced between bone and soft tissue following microwave diathermy.

## Review of Literature

Weinberg and Ward[5a] in 1934 recorded temperatures in the leg of anes-

* Read at the Twenty-Seventh Annual Session of the American Congress of Physical Medicine, Cincinnati, Sept. 7, 1949.

* Abridgment of thesis submitted by Doctor Engel to the Faculty of the Graduate School of the University of Minnesota in partial fulfilment of the requirements for the degree of Master of Science in Physical Medicine.

1. (*a*) Leden, U. M.; Herrick, J. F.; Wakim, K. G., and Krusen, F. H.: Preliminary Studies on the Heating and Circulatory Effects of Microwaves—"Radar," Brit. J. Phys. Med. **10**:177 (Nov.-Dec.) 1947. (*b*) Siems, L. L.; Kosman, A. J., and Osborne, S. L.: A Comparative Study of Short Wave and Microwave Diathermy on Blood Flow, Arch. Phys. Med. **29**:759 (Dec.) 1948. (*c*) Horvath, S. M.; Miller, R. S., and Hutt, B. K.: Heating of Human Muscle Tissue by Microwaves, Federation Proc. **7**:55 (Mar.) 1948. (*d*) Osborne, S. L., and Frederick, J. N.: Microwave Radiations, J. A. M. A. **137**:1036 (July 17) 1948.

2. (*a*) Kemp, C. R.; Paul, W. D., and Hines, H. M.: Studies Concerning the Effect of Deep Tissue Heat on Blood Flow, Arch. Phys. Med. **29**:12 (Jan.) 1948. (*b*) Worden, R. E.; Herrick, J. F.; Wakim, K. G., and Krusen, F. H.: The Heating Effects of Microwaves With and Without Ischemia, ibid. **29**:751 (Dec.) 1948. Leden, Herrick, Wakim and Krusen.1a. Siems, Kosman and Osborne. 1b.

3. Rae, J. W., Jr.; Herrick, J. F.; Wakim, K. G., and Krusen, F. H.: A Comparative Study of the Temperatures Produced by Microwave and Short Wave Diathermy, Arch. Phys. Med. **30**:199 (April) 1949.

4. (*a*) Wise, C. S.; Castleman, B., and Watkins, A. L.: Effect of Diathermy (Short Wave and Microwave) on Bone Growth in the Albino Rat, J. Bone & Joint Surg. **31A**:407 (July) 1949. (*b*) Salisbury, W. W.; Clark, J. W., and Hines, H. M.: Exposure to Microwaves, Electronics **22**:66 (May) 1949.

5. (*a*) Weinberg, E. D., and Ward, G. E.: Diathermy and Regeneration of Bone, Arch. Surg. **28**: 1121 (June) 1934. (*b*) Schliephake, E.: Short Wave Diathermy, second English edition, London, The Actinic Press, 1938. (*c*) Cumberbatch, E. P., and others: Diathermy Including Diathermotherapy and Other Forms of Medical and Surgical Electrothermic Treatment, ed. 2, Baltimore, William Wood & Company, 1927. (*d*) Bachem, A.: Selective Heat Production by Ultrashort (Hertzian) Waves, Arch. Phys. Therapy **16**:645 (Nov.) 1935. (*e*) Osborne, S. L., and Coulter, J. S.: Thermal Effects of Short Wave Diathermy on Bone and Muscle, ibid. **19**:281 (May) 1938. (*f*) Wise, Castleman and Watkins.4a

thetized dogs by means of thermometers inserted into the bone and into the soft tissus. They raised the temperature of bone to 102 F. with conventional diathermy without injury to soft tissue. When the temperature of bone was raised to 106 F., there was burning of the soft tissues. They noted that repair of injured bone was augmented when daily diathermy at predetermined safe doses was used. The authors attributed the increased rate of repair of the injured bone to an increase in the circulation and physiologic activity produced by diathermy.

Schliephake[55] exposed the leg of a living dog to the condenser field (short wave diathermy) and to diathermy (conventional diathermy) and measured, by means of a thermometer, the temperatures which were produced. With the condenser field the bones became heated the most and the subcutaneous tissues the least. However, with a diathermy the reverse was the case.

Cumberbatch[56] reported that when an amputated human limb was placed in the condenser field, the highest temperature was obtained in the fatty tissues and the temperature of the interior of the bone rose to about one-half the value obtained in the subcutaneous fatty tissues. When the same leg was subjected to the diathermic current (conventional diathermy), the temperature of the subcutaneous fat quickly rose to a much higher level and the temperature of the bone rose slowly and attained a lower value than when the leg was exposed to the condenser field. Conventional diathermy, when the leg of the living dog was used, produced a higher rise of temperature in the subcutaneous fat than in the muscle or bone. The reverse was observed when the limb was heated in a condenser field at a higher frequency.

Bachem[58] reported that bones heated selectively with high frequency currents. Boiling the bones in water to remove the organic substances did not alter the heating characteristics. For a 5 meter wave, the relative heating in descending order was fat, bone marrow, bone, lung, skin, spleen, liver and hair.

Sheard and Pratt[6] measured temperatures in the leg bone of a dead animal with thermocouples before and after exposure of the limb to a high frequency field of 27.5 megacycles. Following a five minute period of diathermy, the temperature of muscle increased 1.2 degrees (C.) while that of the bone cavity increased 3.3 degrees.

Osborne and Coulter[59] in 1938 subjected the thighs of anesthetized large dogs to short wave diathermy at wavelengths of 6, 12 and 24 meters. Temperatures were measured by means of thermocouples inserted through rubber cannulas placed into the muscle at a depth of 1.5 inches (3.8 cm.) and into bone before and immediately after diathermy. After a twenty minute exposure of the mesial surface of the thigh, highest temperatures were obtained when electromagnetic induction (wavelength of 24 meters) was used. The average temperature of the bone marrow was 107.4 F., and that of the muscle was 111.4 F. When physiologic doses were exceeded, the degree of injury decreased from the periphery to the interior.

Osborne and Frederick[61] produced with microwaves average temperatures of 105.1 F. in the frontal sinus of dogs when the rectangular director was used. This was an increase of 10 degrees (F.) over the control temperatures.

Wise and associates[16] gave single exposures of either condenser field short waves (8 meter wavelength) or microwaves (11 cm. wavelength) to the region of the knee joint of the albino rat. Destruction of bone and im-

6. Sheard, Charles, and Pratt, Carol B.: Change in Temperatures of Tissues After Systemic Applications of Short Wave Electric Fields, Proc. Soc. Exper. Biol. & Med. 31:763, 1934-1935.

paired growth were present only when immediate surface effects of varying degrees, from severe damage to moderate swelling, were also noted.

The manufacturers[7] of the Raytheon microtherm found in their studies on horseflesh and bone that the temperature of bone could be increased when a frequency of 2,450 megacycles was used but not to as high levels as that of flesh. They postulated that the exceedingly low dielectric constant of animal bone marrow prevents absorption of any measurable amount of energy, with the result that little or no increase in temperature is obtained.

## Methods

A Raytheon microtherm was used as the source of energy. Oscillations at a frequency of 2,450 megacycles per second, corresponding to a wavelength of 12.2 cm., were transported from the generator to the director by means of a coaxial cable. The microwaves transmitted from the director were applied to the animal. The hemispherical director produces a circular surface-heating pattern with a maximal zone of heating approximately one-third of an inch (0.8 cm.) within the outer circumference of the director when the director is at a distance of 2 inches (5.1 cm.) from the skin. The rectangular director produces an elliptic surface-heating pattern with a maximal concentration of heat in the center. The distance from the director to the shaven skin of the animal was maintained at 2 inches throughout this study. The output of the generator was adjusted for each director beforehand to produce approximately equal heating in isolated horseflesh when the director was 2 inches from the flesh.

Temperatures were measured by means of thermistors and needle thermocouples (copper-constantan). The thermistor[8] is a thermally sensitive resistor with a negative temperature coefficient. Thermistors were left in the tissues during exposure to microwaves, and the temperatures were recorded every five minutes. Since temperatures obtained by this method cannot be observed accurately while microwaves are present, it was necessary to turn the plate current off every time temperatures were recorded. An interval of fifteen seconds was permitted to elapse after the plate current was turned off in order to insure accurate observations of temperatures. Temperatures were recorded with thermocouples before and after exposure of the tissues to microwaves. The thermocouples were removed completely from the electromagnetic field during exposure to microwaves. When the two methods were compared simultaneously, there was no significant difference in the temperatures. Thermocouples were employed for measurement of soft tissue temperatures in trained dogs. Calibration of both thermistors and thermocouples with a Bureau of Standards thermometer was accurate to within ±0.2 degree C. All temperatures were measured within the area of maximal heating.

Two groups of large dogs were used: Those of group 1 were anesthetized with pentobarbital sodium, and those of group 2 were trained.

The upper third of the tibia was selected because of its accessibility. Through a small incision into the anterior aspect of the leg 1.5 cm. below the tibial tuberosity the bone was exposed. One burr hole was drilled into the tibial cortex to a depth of 1/4 to 3/8 inch (0.6 to 1 cm.), and a second hole was directed into the marrow cavity. One thermistor was placed into each hole, and the soft tissues were then sutured. Additional thermistors were inserted into the adjacent muscle at a depth of 1.4 cm. and into subcutaneous tissues by means of 15 gauge needles through separate punctures. The needles were then withdrawn along the insulated lead wires contained in the polythene tubing.

When trained animals were used, thermistors were placed into the bone cortex and marrow with the dog under ether anesthesia and with aseptic precautions. The lead wires were channeled upward subcutaneously and exteriorized through a stab wound on the lateral aspect of the thigh. The exposed leads were protected by dressing, and the knee joint was splinted to prevent injury to the thermistors when observations on temperatures were not in progress. Before every set of determinations roentgenologic examination of the leg was conducted daily to verify the location of the thermistors and thus insure correct placement of the director for maximal irradiation.

In order to observe temperatures in subcutaneously located bone, microwaves were directed to the medial aspect of the leg; and in order to observe the temperatures in submuscularly located bone, the lateral aspect of the leg was exposed to microwaves.

7. Council on Physical Medicine: Raytheon Microtherm Acceptable, J. A. M. A. 135:986 (Dec. 13) 1947.

8. Becker, J. A.; Green, C. B., and Pearson, G. L.: Properties and Uses of Thermistors-Thermally Sensitive Resistors, Electrical Engineering (Nov.) 1946.

Director "A" at a distance of 2 inches from the skin was used in the initial studies; director "C," which was placed parallel to the limb at a distance of 2 inches, was used in the later studies. The output of the generator was 65 watts (75 milliampere current) for director "A" and 32.5 watts (45 milliampere current) for director "C." The duration of exposure varied from five to thirty minutes.

In order to determine the influence of underlying bone on muscle temperature following exposure of the lateral aspect of the hind leg to microwaves, comparison of temperatures in the tibialis anterior and the gastrocnemius at a depth of 1.4 cm. was made in 5 trained dogs. Temperatures were determined by means of thermocouples.

Based on the determination of the dielectric constant of dog muscle with a microwave dielectrometer,[2] an impedance-matching transformer was developed. This device was placed on the shaven skin of the dog squarely beneath the microwave director in the area of maximal irradiation.

## Observations

*Heating Effects on Subcutaneously Located Bone.* — The average initial temperatures in 5 anesthetized dogs, based on 14 observations, were 36.5 C. in the subcutaneous tissue, 36.7 C. in the tibial cortex, 37.9 C. in the tibial marrow and 36.4 C. in the gastrocnemius muscle. The average rectal temperature was 38.2 C. Thirty minutes of exposure at 65 watts produced an average temperature rise of 4.1 degrees (C.) in the subcutaneous tissue, 5.0 degrees in the tibial cortex, 3.4 degrees in the tibial marrow and 4.3 dgrees C. in the gastrocnemius muscle. The average rise in the temperature of the tissues beneath the tibia was 2.1 degrees; the average rise in rectal temperature was 0.2 degrees (figs. 1 and 2).

*Heating Effects on Submuscularly Located Bone.* — The average initial temperature in 13 observations on 4 dogs was 36.8 C. in the subcutaneous tissues, 37.9 C. in the overlying tibialis anterior muscle, 37.6 C. in the tibial cortex and 38.2 C. in the tibial marrow. The average rectal temperature was 39.0 C. Thirty minutes of exposure of the lateral aspect of the leg at 65 watts produced average temperature increments of 4.3 degrees (C.) in the subcutaneous tissues, 4.0 degrees in the tibialis anterior muscle, 3.8 degrees in the tibial cortex and 3.0 degrees in the tibial marrow. The average increase of rectal temperature was 0.3 degrees (figs. 3 and 4).

When the rectangular director was used, it was possible to produce higher temperatures in the subcutaneously located bone without excessively heating the adjacent soft tissue. (This director concentrates the energy in the center of an elliptical pattern.)

In 7 observations on 2 anesthetized dogs, with this director being employed parallel to the leg for twenty minutes at a distance of 2 inches from the skin and with a generator output of 32.5 watts, the temperature rises were 5.1 degrees (C.) in the tibial cortex, 4.0 degrees in the tibial marrow, 3.4 degrees in the adjacent gastrocnemius muscle and 4.0 degrees in the subcutaneous tissues (fig. 5).

When similar conditions in the trained dogs were employed, average temperatures were about 1 degree lower than in anesthetized dogs.

*Effect of Impedance Matching.* — Several preliminary studies on anesthetized dogs revealed that when an impedance-matching transformer was placed in the field of irradiation higher tissue temperatures were produced than with microwaves alone. For comparison of temperatures in trained dogs, it was necessary to decrease the power output to 37.5 watts (director "A") and to reduce the exposure time to ten minutes to offset decrease in tissue temperature which occurs when the blood flow increases after microwave diathermy at a higher power output.

2. Roberts, S., and Von Hippel, A.: A New Method for Measuring Dielectric Constant and Loss in the Range of Centimeter Waves, J. Applied Physics 17:610 (July) 1946.

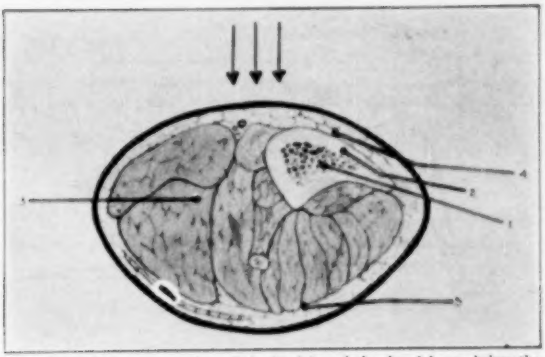


Fig. 1. — Transverse section of the hind leg of the dog 1.5 cm. below the tibial tuberosity showing the position of each thermistor when temperatures were observed. Arrows indicate direction of irradiation on the medial aspect of the leg.

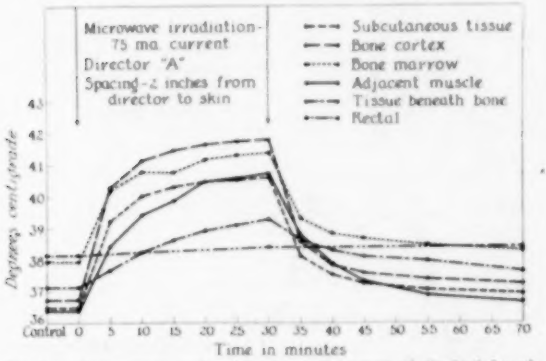


Fig. 2. — Temperatures produced in the medial aspect of the hind leg of the anesthetized dog after varying periods of microwave diathermy. The cooling curve begins after thirty minutes of exposure.

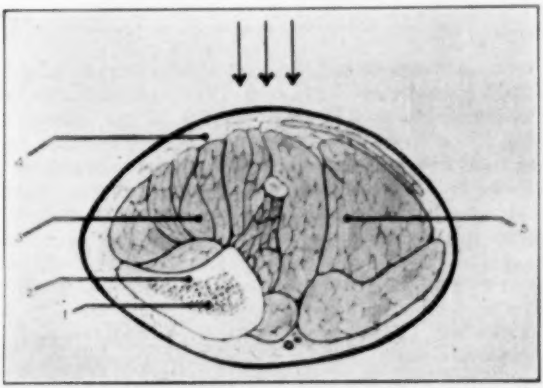


Fig. 3. — Transverse section of the hind leg of the dog 1.5 cm. below the tibial tuberosity showing the position of each thermistor when temperatures were observed. Arrows indicate the direction of irradiation on the lateral aspect of the leg.

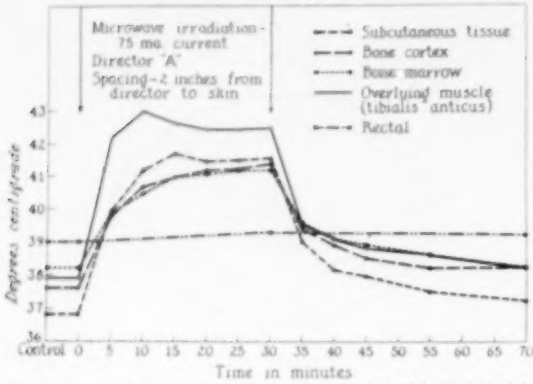


Fig. 4. — Temperatures produced in the medial aspect of the hind leg of the anesthetized dog after varying periods of microwave diathermy. The cooling curve begins after thirty minutes of exposure.

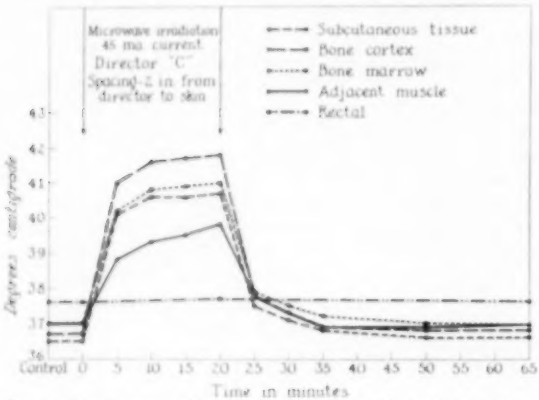


Fig. 5. — Temperatures produced in the medial aspect of the hind leg of the anesthetized dog after varying periods of microwave diathermy. The cooling curve begins after twenty minutes of exposure.

When submuscular bone was exposed to microwaves without the impedance-matching transformer for a period of ten minutes, the average rises of temperature were 0.53 degrees (C.) in the cortex, 0.44 degree in the marrow, 1.49 degrees in the overlying muscle and 0.98 degrees in the subcutaneous tissues. However, when the impedance-matching transformer was placed in the field over the area of maximal irradiation, the average rises of temperature were 1.35 degrees (C.) in the cortex, 1.36 degrees in the marrow, 4.7 degrees in the muscle and 4.11 degrees in the subcutaneous tissues (fig. 6). In a similar study made on subcutaneously located bone exposed to microwaves without and with an impedance-matching transformer in the field, the rises of temperature were, respectively 1.1 and 3.25 degrees (C.) in the cortex, 1.1 and 4.4 degrees in the marrow and 1.04 and 3.37 degrees in the subcutaneous tissues. The average rises of temperature in the adjacent gastrocemius muscle were 2.63 and 5.51 degrees (fig. 7).

Rises of cutaneous temperature with exposure to microwaves alone were 0.8 degree over the tibia and 1.6 degrees over the gastrocnemius muscle.

When the transformer was used, the cutaneous temperatures were 3.0 degrees over the tibia and 4.6 degrees over the gastrocnemius muscle. In 1 trained dog, when a power output of 65 watts was used for a period of seven minutes, there was very slight blistering of the skin, which disappeared after forty-eight hours. The temperature of the muscle was 44 C.

*Effect of Bone on the Temperature of Overlying Muscle.* — Comparison of temperatures at a depth of 1.4 cm. in the anterior tibialis and the gastrocne-

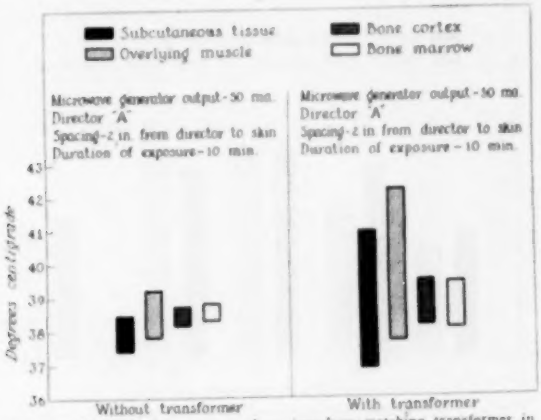


Fig. 6. — Effect of the presence of an impedance-matching transformer in the irradiated zone on the temperature in submuscular bone and adjacent tissues of the trained dog.

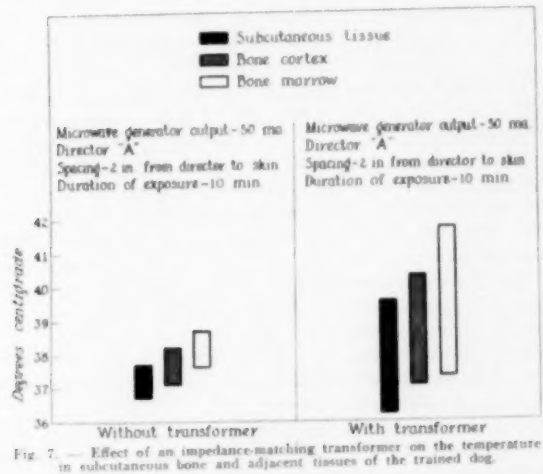


Fig. 7. — Effect of an impedance-matching transformer on the temperature in subcutaneous bone and adjacent tissues of the trained dog.

mius muscls before and after microwave exposure to the lateral aspect of the leg was made in 5 trained dogs. After five, ten, fifteen, twenty and thirty minutes of exposure, the rises of temperature in the overlying tibialis anterior and in the adjacent gastrocnemius muscles were, respectively 3.60 and 3.10 degrees (C.); 5.54 and 4.39 degrees; 6.04 and 6.08 degrees; 5.56 and 6.50 degrees, and 4.11 and 3.89 degrees (fig. 8).

## Comment

Subcutaneously located bone appeared to have become heated to a greater extent than did submuscularly located bone. It must be stated, however, that even though the distance from the director to the skin was the same for the two procedures, the submuscular bone was separated from the skin by the thickness of the muscle, which was approximately 1.5 cm.

The rectangular director placed parallel to the longitudinal axis of the

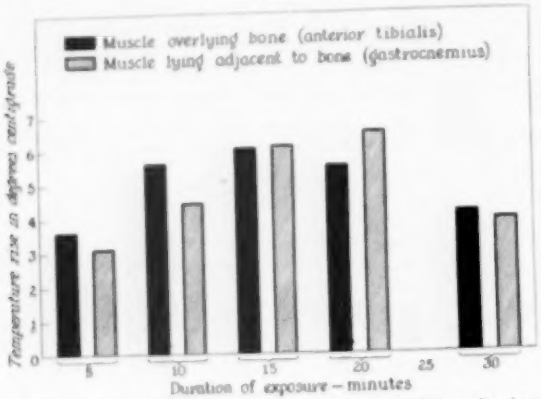


Fig. 8. — Comparison of temperature rises in muscle that overlies bone and in muscle under which no bone exists, in trained dogs. Director "A," a power output of 65 watts, and a director distance 2 inches from the skin were used.

extremity was found to be more suitable than other types of directors for heating subcutaneously located bone. This is due to the fact that the maximal concentration of energy is on the bone.

When the lateral aspect of the hind leg in anesthetized dogs was exposed to microwaves for a thirty minute period, the muscle overlying bone attained its average peak temperature (43 C.) at the end of ten minutes of exposure. The temperature decreased thereafter despite continued diathermy (fig. 4). During a similar period of exposure in trained dogs the muscle (tibialis anterior) overlying bone attained its average peak temperature (42.1 C.) at the end of fifteen minutes, after which time the temperature decreased. The muscle (gastrocnemius) which did not overlie bone attained a peak temperature (42.9 C.) at the end of twenty minutes of irradiation (fig. 8).

Raytheon laboratory workers found in their studies on horseflesh and bone that when bone underlay flesh at a depth of less than 1 cm. the flesh was heated substantially more than if the bone was not present. When the bone underlay flesh at a depth of more than 1 cm., the heating of tissues was the same as when no bone was present.

Worden and co-workers[20] reported that in all ischemic extremities in which burns occurred, the first evidence of burning appeared in the tissues over the femur in the zone of maximal output of energy for the director used. Leden and associates[18] observed an increase of blood flow in the femoral vein and said that the increase was greater toward the end of the period of exposure of the thigh of the dog to microwaves.

Gersten and associates[19] correlated plethysmographically the tissue tem-

19. Gersten, J. W.; Wakim, K. G.; Herrick, J. F., and Krusen, F. H.: The Effect of Microwave Diathermy on the Peripheral Circulation and on Tissue Temperature in Man, Arch. Phys. Med. 30:7 (Jan.) 1949.

peratures and blood flow in human beings following microwave diathermy. They found that the greater the increase of circulation, the greater the decrease of the temperature of the exposed tissues from the maximal values reached.

On the basis of the evidence observed in the aforementioned studies, including our own, it is postulated that the presence of bone aids in raising the temperature of the overlying muscle following microwave diathermy. An increase in the circulation is then produced which provides a good means for the dispersal of heat.

## Summary

Microwave diathermy was applied to the legs of anesthetized and trained dogs, and temperature measurements were taken before and after irradiation by means of thermistors and thermocouples placed into the adjacent soft tissues and into the bone cortex and bone marrow of the upper third of the tibia.

When submuscular bone was exposed to microwaves for a period of thirty minutes, the average increases of temperature were 4.3 degrees (C.) in the subcutaneous tissues, 4.6 degrees in the overlying tibialis anterior muscle, 3.8 degrees in the tibial cortex and 3.0 degrees in the tibial marrow. The average increase of rectal temperature was 0.3 degree.

When subcutaneous bone was exposed to microwaves for a thirty minute period, the average increases of temperature were 4.1 degrees (C.) in the subcutaneous tissue, 5.0 degrees in the tibial cortex and 3.4 degrees in the tibial marrow, and 4.3 degrees in the adjacent gastrocnemius muscle. The average increase of rectal temperature was 0.2 degree.

Subcutaneously located bone was heated most effectively with microwaves when the rectangular director was placed parallel to the extremity.

Average rises of temperature of the leg tissues in trained dogs following exposure to microwaves were approximately 1 degree (C.) less than those obtained under similar procedures in anesthetized dogs.

When the lateral aspect of the leg was exposed to microwaves, higher temperatures were developed in the tibialis anterior, which overlies bone, than in the gastrocnemius, which does not overlie bone, provided the time of exposure did not exceed fifteen minutes.

An impedance-matching transformer placed in the field of microwave irradiation caused an increase in the tissue temperature of approximately 300 per cent over the values obtained when no transformer was used.

## NOTICE TO CONGRESS MEMBERS

Please take notice that at the last annual business meeting of the Congress, September 6 and September 7, 1949, Netherland Plaza Hotel, Cincinnati, Ohio, the following amendments to the Constitution and By-Laws were presented in writing to the meeting:

1. Amend Article I of the Constitution of the American Congress of Physical Medicine to read as follows:

"The name of this organization is the American Congress of Physical Medicine and Rehabilitation, hereafter referred to as the Congress."

2. Amend Article X, Section 1 of the Constitution to read as follows:

"The official publication of the Congress is the ARCHIVES OF PHYSICAL MEDICINE AND REHABILITATION, in which shall be published all official Congress notices and transactions of sessions of the Congress, either in abstract or in full. The management of the ARCHIVES OF PHYSICAL MEDICINE AND REHABILITATION shall be vested in an Editorial Board to be constituted as provided for in the succeeding section."

3. Amend Chapter V, Section 9 of the By-Laws to read as follows:

"The Committee on Advances in Education consists of five members appointed by the President each year. This Committee shall cooperate with the Councils on Physical Medicine and Rehabilitation and Medical Education and Hospitals of the American Medical Association. All questions pertaining to education and physical medicine shall be referred to this Committee for consideration and action.

4. Amend Article XVI of the Constitution to read as follows:

"This Constitution may be amended in whole or in part at any annual business meeting by a two-thirds vote of all voting members present and voting provided that prior to that time the amendment—

(1) Has been presented in writing at the previous annual business meeting, and

(2) A copy of the proposed amendment, together with a notice that the matter will be voted on, is sent by mail to each member or is published in the ARCHIVES OF PHYSICAL MEDICINE and REHABILITATION not less than one month in advance of the annual business meeting at which action is to be taken."

5. Amend title of Article VIII of the Constitution to read as follows:

"ARTICLE VIII — AMERICAN REGISTRY OF PHYSICAL THERAPISTS"

6. Amend Article VIII, Section 1 of the Constitution to read as follows:

"This organization shall operate a Registry for the purpose of maintaining a list of physical therapists competent and qualified to administer adequate physical therapy under the prescription, direction and specific supervision of licensed physicians.

"All matters pertaining to the functioning of the Registry shall be managed by a Board of Registry, which shall be composed of seven members, to be appointed by the President of the Congress and confirmed by the voting members of the Congress. Only such members of the Congress as are in good standing in the Congress and practice physical medicine exclusively shall be eligible for appointment to and continuance on the Board of Registry. Each member shall serve a term of seven years, so arranged that the ultimate objec-

*(Continued on page 464)*

ARCHIVES of PHYSICAL MEDICINE

OFFICIAL PUBLICATION AMERICAN CONGRESS OF PHYSICAL MEDICINE

# .·. EDITORIALS .·.

## SCHEDULE OF EXAMINATIONS
## AMERICAN BOARD OF PHYSICAL MEDICINE AND REHABILITATION

**The examinations for the American Board of Physical Medicine and Rehabilitation, to be held in Boston, August 26 and 27, are scheduled as follows: Part I (written) will be given at the Harvard Medical School, Building B-II, Room 203, on Saturday, August 26, 9 A. M. Part II (oral) will be given at the Department of Physical Medicine, Massachusetts General Hospital, Sunday, August 27.**

## NEW SECTION OF PHYSICAL MEDICINE AND REHABILITATION OF THE AMERICAN MEDICAL ASSOCIATION IS LAUNCHED

At the annual meeting of the American Medical Association in San Francisco, June 26 to 30, 1950 which was attended by over 10,000 physicians, the new Section on Physical Medicine and Rehabilitation was launched with flying colors. During the three sessions of the new section various phases of physical medicine and rehabilitation were ably discussed by a galaxy of well qualified physiatrists from all parts of the United States. Fundamental subjects such as therapeutic exercise, medical physics and functional retraining were discussed and excellent papers were presented on physical medicine and rehabilitation in such diseases as hemiplegia, degenerative joint disease, spastic disorders, poliomyelitis, brain damage, amputations and paraplegia.

In addition to the three scientific sessions, the new section presented an excellent series of exhibits including a fine symposium on speech rehabilitation, a beautifully prepared demonstration on the rehabilitation of the amputee, an exhibit on vocational rehabilitation, an exhibit on self-help devices in activities of daily living, an exhibit on rehabilitation of the blind, one on pool therapy in poliomyelitis, one on the basic physiology of skeletal muscle and one on muscular re-education in neuro-muscular disorders. The Committee on Scientific Exhibits presented an award to Drs. George G. Deaver, Donald A. Covalt and Howard A. Rusk of New York University College of Medicine for their significant presentation on "Self-help devices in activities of daily living."

At the first business session of the new section, the following officers were elected: Chairman, Dr. George Morris Piersol, Philadelphia; Vice-Chairman, Dr. Howard A. Rusk, New York; Secretary, Dr. Walter J. Zeiter, Cleveland; Representative of the section to the Committee on Exhibits, Dr. Arthur L. Watkins, Boston; Delegate from the section to the House of Delegates, Dr. Frank H. Krusen, Rochester, Minnesota; Alternate delegate, Dr. Walter M. Solomon, Cleveland; Nominee to represent the section on the American Board of Physical Medicine and Rehabilitation, Dr. Donald A. Covalt, New York.

In his Chairman's Address to the new section, the retiring Chairman, Dr. Frank H. Krusen, stated: "At this moment we physicians who specialize

in physical medicine and rehabilitation are riding on the crest of the flood and our future should be extremely bright if we will continue to bend every effort to promote good practice, sound teaching and conscientious research. We must not omit any step in collaborating with our colleagues in other specialties which will advance the welfare of our patients." He added, "It is obvious that the scope of our new medical discipline is enormous and that the future of our specialty is promising. Our recent progress has been truly phenomenal and this field which is based on the medical application of physics should continue its expansion and in the future should attain new heights in this 'age of physics'."

## NOTICE TO CONGRESS MEMBERS

*(Continued from page 462)*

tive shall be one appointment and confirmation annually. If before the expiration of the term for each was elected, a member of the Board dies, is removed or becomes disqualified, the President of the Congress shall designate a qualified person to serve the unexpired portion of the term."

This is to serve as notice to the members of the Congress, in accordance with the provisions of Article XVI of the Constitution relating to amendments, that at the forthcoming annual business meeting of the Congress, to be held at 8 P. M., Monday, August 28, at the Hotel Statler, Boston, the proposed amendments set out above will be voted on for adoption or rejection.

**CHANGE OF ADDRESS**

Send your new address at least 30 days before the month of the issue with which it is to take effect. Address

**THE ARCHIVES OF PHYSICAL MEDICINE**
**30 North Michigan Avenue, Chicago 2, Ill.**

Send old address with the new, enclosing if possible your address label. The Post Office will not forward copies unless you provide extra postage. Duplicate copies cannot be sent.

# MEDICAL NEWS

## B for Best

B is for best — the best convention ever of the Congress. B is also for Boston which has the largest horticultural library and collection of shoes in the world. Boston is the home of the first public school, first college, first corporation, first newspaper, first railway, first subway, first State medical society in the United States.

Come early and stay late. You can take a boat ride to Providence where the Pilgrims landed before they touched Plymouth and where Portugese is the official language. You can attend the largest dog race track in America and one of the finest horse race tracks in the country in your spare time. You can see the famous Blaschka collection of glass flowers at Harvard, or take a boat ride on the Charles River. You can see where the Concord grape was born or where the first ether operation was performed. You can also see ultrasound therapy practiced daily.

On your way back you can take a bus trip to the wonderful Rehabilitation Center at Rocky Hill, Connecticut or the bus will bring you back to Boston on the same day.

Bring your wife and children. There will be special attractions for all.

## Come to Rocky Hill

Members of the American Congress of Physical Medicine are invited to visit the Department of Physical Medicine and Rehabilitation, State of Connecticut Veterans' Home and Hospital — Hospital for Chronic Illness, Rocky Hill, Connecticut, any week before, during or after the convention. The Department of Physical Medicine and Rehabilitation is closed week-ends and will be closed on Labor Day.

Hartford is half way between New York and Boston. New York trains and planes will all stop at Hartford. There is direct plane service from Chicago to Hartford.

Arrangements will be made to meet you upon your arrival in Hartford if Dr. Nila Kirkpatrick Covalt is notified of your arrival by mail previously, or you may telephone her at the time of your arrival in Hartford, telephone 9-2571.

## Personals

On May 18, at the second Western Michigan Clinic Day of the Kent County Medical Society in Grand Rapids, Dr. Richard Kovacs spoke on "What Physical Therapy Has to Offer the Practicing Physician." On May 19, at the meeting of the Chicago Society of Physical Medicine and Rehabilitation, Dr. Kovacs presented the subject "The Evolution of Physical Medicine Rehabilitation in Organization Work."

Dr. Robert M. Stecher has been elected president of the Cleveland Health Museum, succeeding Dr. Lester Taylor, founder, who died suddenly while on vacation, April 11. Dr. Stecher is a founder-member of the Cleveland Health Museum, a member of the Board of Trustees, and has been chairman of the Committee on Foundations. He has been a member of the medical staff at Cleveland City Hospital since 1926 and assistant clinical professor of medicine, Western Reserve University Medical School since 1940.

Dr. Frank H. Krusen of Rochester, Minnesota, presented the topic "Physical Medicine in Europe with Reference to the Crippled Child" at the tenth anniversary celebration of the Alfred I. duPont Institute, Wilmington, Delaware, on June 17.

The annual meeting of the Association for Physical and Mental Rehabilitation was held at the Hotel Peabody, Memphis, Tenn., May 23-27. The following papers were presented: "Teaming for Rehabilitation," Alvin B. C. Knudson, Washington, D. C.; "Functional Bracing," Robert L. Bennett, Warm Springs, Ga., and "Medical Aspects of the Neurologic Patient," by Ben L. Boynton, Houston, Texas.

At the recent meeting of the Minnesota State Medical Association held in Duluth, Minnesota, June 12 to 14, Mr. Howard A. Carter, Secretary of the Council on Physical Medicine and Rehabilitation of the American Medical Association, presented the following topic: "The Physics of Atomic Energy and the Geiger-Mueller Counter."

At the annual meeting of the South Dakota State Medical Association held May 21-23 in Huron, South Dakota, Dr. Earl C. Elkins presented the following topic: "Treatment of Convalescent Poliomyelitis."

Dr. Nicholas Mauriello announces the opening of Laurel Hospital and Clinic. Dr. Mauriello is assistant in physical medicine at the Episcopal Hospital of Philadelphia and consultant to the Veterans Administration in physical medicine and rehabilitation.

Dr. Jacob L. Rudd of Boston was recently elected second vice-president of the American Psychiatric Association at its annual meeting in Detroit.

The annual session of The Medical Society of the State of North Carolina was held in Pinehurst, May 1 to 3. Dr. George D. Wilson of Asheville was a general sessions speaker and spoke on Treatment of Febrositis of Neck and Shoulder with Microthermy (Radar).

Dr. Joseph Koczur has been appointed instructor in physical medicine in the department of pharmacology and therapeutics, Stritch School of Medicine, Loyola University, Chicago. He has also been appointed director of physical medicine

at Mercy Hospital and associate physiatrist, Cook County Hospital, Chicago.

Dr. Herbert Kent, Chief, Physical Medicine Rehabilitation, VA, Indianapolis, Indiana, has been transferred to Hines, Illinois, on temporary detail for the purpose of monitoring and to assist in the teaching of a ten week course in Physical Medicine Rehabilitation given to physicians. Dr. Louis B. Newman is directing the course.

## Report American Registry Physical Therapy Technicians

### Period Jan. 1 to Dec. 31, 1949

| | |
|---|---|
| Number registrations completed | 500** |
| Number examinations conducted | 446 |
| Number retake examinations conducted | 30 |

| | 1948 | 1949 |
|---|---|---|
| Number of requests for qualified personnel | 637 | 761 |
| Number of requests for positions | 427 | 452 |
| Number of placements completed | 174 | 194 |

### Certificates Issued According to School of Graduation

| Name of School | Number of Graduates Registered |
|---|---|
| Albany Hospital, Albany, N. Y. | 5 |
| Boston University College of Physical Education for Women, Sargent College, Cambridge, Mass. | 25 |
| Bouve-Boston School of Physical Education, Boston | 10 |
| University of California Hospital, San Francisco | 27 |
| Children's Hospital, Los Angeles | 12 |
| University of Colorado Medical Center, Denver | 16 |
| Columbia University College of Physicians and Surgeons, New York City | 34 |
| Duke Hospital, Durham, N. C. | 1 |
| Harvard Medical School (Children's Hospital), Boston | 11 |
| Hermann Hospital, Houston | 7 |
| State University of Iowa Medical School, Iowa City | 10 |
| University of Kansas School of Medicine, Kansas City | 16 |
| *Lawson General Hospital, Atlanta, Ga. | 1 |
| Mayo Clinic, Rochester, Minn. | 29 |
| University of Minnesota, Minneapolis | 17 |
| New York University School of Education, New York City | 62 |
| Northwestern University Medical School, Chicago | 15 |
| *O'Reilly General Hospital, Springfield, Mo. | 1 |
| Graduate Hospital of the University of Pennsylvania, Philadelphia | 34 |
| Baruch Center of Physical Medicine of the Medical College of Virginia in Affiliation With Richmond Professional Institute, Richmond | 36 |
| St. Louis University School of Nursing, St. Louis | 3 |
| University of Southern California, Los Angeles | 13 |
| Stanford University, Stanford University, Calif. | 42 |
| University of Texas School of Medicine, Galveston | 6 |
| Medical Department — U. S. Army — | |
| Medical Field Service School, Brooke Army Medical Center, San Antonio, Texas | 1 |
| Walter Reed General Hospital, Army Medical Center, Washington, D. C. | 5 |
| Washington University School of Medicine, St. Louis | 9 |
| D. T. Watson School of Physiatrics, Leetsdale, Pa. | 36 |
| University of Wisconsin Medical School, Madison | 16 |
| | 500 |

* War Emergency Course.
** Twenty-four students registered in 1949 wrote the examination the latter part of December, 1948.

## New Jersey Society of Physical Medicine

At the state meeting in Atlantic City, May 20, the following were elected: President, Joseph F. A. Rubacky, M.D.; Vice-President, Elmer J. Elias, M.D.; Treasurer, Thomas P. McConaghy, M.D., and Secretary, James C. Hanrahan, M.D.

## Leading Experts Survey Cleveland Rehab Service

Greater Cleveland's needs in physical medicine and rehabilitation are to be determined by a survey which began this month.

Commissioned for the task are Dr. Howard A. Rusk, international authority on rehabilitation, and his associate, Eugene J. Taylor, of New York.

The decision to make the survey grew out of a meeting called by the School of Medicine at Western Reserve University at which representatives of the School, Cleveland Rehabilitation Center, Rose-Mary Home, University Hospitals and Warrensville Infirmary, discussed their needs.

Grants for the project came from Cleveland Foundation, the Prentiss Foundation and the Beaumont Trust Fund.

Mr. Taylor initiated the survey March 17 with a meeting of all Cleveland groups involved in physical medicine and rehabilitation. It is hoped to develop an efficient plan for improved rehabilitation services for the chronically ill and disabled.

At the preliminary meeting at the medical school, discussion revealed urgent needs among organizations now giving rehabilitation services. Needs listed included a medical expert in physical medicine to supervise therapists in one agency; and physical and occupational therapy for another. The school of medicine, according to newspaper reports, wants an extensive teaching program in physical medicine, to include problems of rehabilitation of patients after active stages of disease or acute aspects of injury.

Cleveland already offers more extensive rehabilitation services than any other community in Ohio.

## Establish School of Auxiliary Medical Service at University of Pennsylvania

The Board of Trustees of the University of Pennsylvania has approved plans for the establishment of The School of Auxiliary Medical Services, the first of its kind in U. S. medical history. The organization of this school embodies within the University structure a new educational medium, which offers programs of study in Physical and Occupational Therapy.

The first two units of the school are to be a Division of Physical Therapy, into which is absorbed The School of Physical Therapy of the Graduate Hospital of the University of Pennsylvania, at 19th and Lombard Streets, Philadelphia; and The Philadelphia School of Occupational Therapy, 419 South 19th Street, which was merged with the University of Pennsylvania as of July 1, 1950.

The purpose of the School of Auxiliary Medical Services is three-fold: (1) To meet the ever-increasing employment demands caused by the rapid expansion of the use of physical and occupational therapy and the recognition of their value in the broad field of rehabilitation; (2) To offer to young men and women, who wish to pursue a career in one of the auxiliary medical services, an opportunity for cultural study and a baccalaureate degree together with basic study, training and certification in a profession; (3) To enlarge the service of the University to the community and to make the group of schools in the medical sciences still more complete.

Two courses of study are offered in each division of the new school, one an undergraduate program leading to a Bachelor of Science degree and the other a certificate course for persons who already hold a bachelor's degree. During the first two undergraduate years the emphasis is on liberal arts courses. A number of highly specialized science courses basic to specialization are included. The programs in the last two years diverge into the chosen area but run along parallel lines with as much coordination as possible. The curriculum is so developed that consideration of a broad educational background is paramount.

Following the attainment of the degree, students in each division are to have a period of practical experience in hospitals and special institutions in which there are well organized physical and/or occupational therapy departments designated as clinical training centers. A certificate of proficiency is granted by the school upon successful termination of the clinical training.

Advanced standing students may transfer into the course any time prior to the beginning of the junior year.

College graduates are admitted for intensive courses in professional preparation which fully qualify them for one of the fields, either physical or occupational therapy.

The school has its own faculty but, as an integral part of the University, can draw upon the almost unlimited resources of the other schools of the University—undergraduate, graduate and professional—for broadening and enriching its program.

The following faculty appointments as officers of The School of Auxiliary Medical Services became effective July first:

Wesley G. Hutchinson, Ph.D., Dean.

George Morris Piersol, M.D., Medical Director of The Division of Physical Therapy.

Dorothy E. Baethke, Professor of Physical Therapy and Director of the Division of Physical Therapy.

Helen S. Willard, Professor of Occupational Therapy, and Director of The Philadelphia School of Occupational Therapy.

Clare S. Spackman, Associate Professor of Occupational Therapy and Assistant Director of The Philadelphia School of Occupational Therapy.

Eleanor J. Carlin, Assistant Professor of Physical Therapy and Assistant Director of the Division of Physical Therapy.

Eleanor Kyle, Assistant Professor of Occupational Therapy, and Assistant Director of The Philadelphia School of Occupational Therapy.

The schools are now accepting applications for admission and will begin operations with the opening of the new academic year 1950-51 at the University of Pennsylvania in September.

## Registered Technicians, May 23, 1950

Barenberg, Florence, M., P. T. Dept., U. of Texas, Galveston, Texas.

Blain, Mary F., 522 Walnut Hill, Roanoke, Va.

Colvin, Priscilla M., 103 Collins Rd., Waban 68, Mass.

Conlin, Nancy K., 156 Babcock St., Brookline 46, Mass.

Cotter, Rosemary M., 848 Hope St., Providence, R. I.

Geoghegan, Mary A., 135 Kendall Ave., Framingham, Mass.

Gossman, Beth J., 2800 42nd St., Des Moines, Ia.

Gratke, Juliette, 212 S. Irving Hts. Dr., Irving, Texas.

Hall, Ruth P., 27 Grand View Ave., Medford 55, Mass.

Hanlon, Bernis M., 18 Hayden Rd., Saugus, Mass.

Liberalis, Sr. Mary, 30 Warren St., Brighton, Mass.

Mantegna, Mr. Alfred, Ontario St., Honeoye Falls, N. Y.

Osgood, Marie R., 3008 E. Genesee St., Syracuse 3, N. Y.

Patricia, Sr. Mary, 30 Warren St., Brighton, Mass.

Pohl, Eulonda M., 1815 Hillsdale Ave., Dayton 5, Ohio.

Stallmann, June N., 628 S. Bridge St., Holyoke, Mass.

Stefanics, Ethel I., 144 Columbia Ave., Vandergrift, Pa.

Watts, Nancy T., 227 E. Jefferson Ave., Naperville, Ill.

Weindell, Mr. Wm. O., 3929 Fairview Ave., St. Louis 16, Mo.

Williams, Elizabeth, 32 Cleveland Rd., Needham, Mass.

Wolnick, Mrs. Arlys J., Rt. 7, Box 448, Charleston Naval Base, S. C.

## Mandell Shimberg

It is with deep regret we announce the sudden death of Dr. Shimberg, a member of the Congress and a diplomate of the American Board of Physical Medicine and Rehabilitation. At the time of his death Dr. Shimberg was Chief, Physical Medicine Rehabilitation, VA Regional Office, New York, N. Y. Dr. Shimberg served in the Medical Corps of the British and the American Army in World War I.

# BOOK REVIEWS

HANDBOOK OF PHYSICAL MEDICINE AND REHABILITATION. Selections authorized for publication by the Council on Physical Medicine and Rehabilitation, American Medical Association. First edition. Cloth. Price, $4.25. Pp. 573, with 81 illustrations. The Blakiston Company, 1012 Walnut Street, Philadelphia 5, Pa., 1950.

The present Handbook of Physical Medicine and Rehabilitation is the fifth version of a book which first appeared in 1932. The original edition called the Handbook of Physical Therapy, consisted of reprints of articles previously published in the Journal of the American Medical Association. The present edition contains many of these original articles in revised form, and it therefore represents the long considered and carefully expressed opinions of recognized authorities in the field. In addition to articles retained from earlier editions, however, articles on medical diathermy, physiologic effects of heat, physiologic aspects of therapeutic exercise, rehabilitation, peripheral vascular disease and artificial limbs have been reprinted from more recent publications, and five articles on fever therapy, problems of hearing, applications in opthalmology, basic principles of therapeutic exercise, and health resorts are printed for the first time. A useful list of motion picture films on physical medicine and rehabilitation forms an appendix.

This book illustrates the gains made by physical medicine in the past two decades, and shows that the subject is still in a stage of rapid development. Further growth is to be anticipated. Those familiar with the published reports of the Council may note that some of its work is still not represented here, for instance, the studies on artificial respiration and respirators, on electrocardiographs and electroencephalographs, and on ionizing radiations other than ultraviolet. Presumably its field will some day be extended to cover all applications of physics in the diagnosis and treatment of disease. Aside from these omissions, the book is fairly representative of a broad subject. It is attractive in appearance, logical in the arrangement of its chapters, and well indexed.

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COUNSELING THE HANDICAPPED IN THE REHABILITATION PROCESS. By *Kenneth W. Hamilton*, Associate Professor of Social Administration, Ohio State University. Cloth. Price, $3.50. Pp. 296, with illustrations. The Ronald Press Company, 15 E. 26th Street, New York 10, 1950.

Technics of physical restoration of the handicapped are on the whole well established and increasingly available. Rehabilitation counseling and vocational guidance, training and placement have not been properly emphasized, and there is a lack of professional personnel in this important aspect of rehabilitation. "Basically, the most important function of the rehabilitation team is in diagnosing and assaying the impact of disability on the diverse facets of the client's life. This permits a wider range of technical services to him. Obviously it also creates a need for integration so that the focus of rehabilitation will remain on the person rather than on the aggregate of his problems and the services he requires. Because of the nature of the counseling relationship, its meaning to the client, and its dynamic effect on the rehabilitation process, the rehabilitation agency must be represented in all its relationships with the disabled client by a single, humanizing personality, the counselor."

This book presents an excellent explanation of the nature and purpose of rehabilitation and in detail describes proper methods, first of all of case findings, and making the rehabilitation diagnosis. The next step is developing the assets of the individual and making a rehabilitation plan, and finally vocational training and selective placement.

An important section deals with developing community resources including the duties of the rehabilitation counselor.

The final section evaluates the known results of rehabilitation and the need for further study. The appendix includes the vocational rehabilitation act, Public Law 113, and an excellent bibliography.

This book is useful for all members of the rehabilitation team including physicians, therapists, social workers, psychologists, counselors and administrative officials. It should be of special value to students and teachers and of interest also to relatives and friends of handicapped individuals.

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HOSPITAL HAPPY. By *Bob Dunn*, M.D. Board. Price, $1.50. Pp. 84, with illustrations. Bell Publishing Company, Drexel Hill, Pa., 1949.

A well known illustrator has added a delightful volume of hilarious drawings and captions to convalescent and drawing room entertainment, by parading off supposedly typical characters in and out of a hospital. One quotation from the flyleaf expresses the spirit of the book: "Bob Dunn, early in life wanted to be a tree-surgeon but went too far out on a limb. One day finding a billet-doux in a hollow tree he delivered it and thus began his interest in obstetrics." And so we see patients, male and female, entering a hospital with a variety of expectations and getting a variety of experiences, with doctors, nurses and internes "act-

ing up." All through the narrative stalks an expectant mother of larger and larger size, until it all ends happily. Doctors, nurses, patients and practically everybody will enjoy this picture book. Get your copy for your waiting room.

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THE CIBA COLLECTION OF MEDICAL ILLUSTRATIONS. A COMPILATION OF PATHOLOGICAL AND ANATOMICAL PAINTINGS. Prepared by *Frank H. Netter*, M.D. Cloth. Price, $6.50. Pp. 222, with 191 illustrations. Ciba Pharmaceutical Products, Inc., Summit, New Jersey, 1948.

This is a colored portrayal of the anatomy and pathology of the lungs and chest, heart and aorta, gastrointestinal tract, the male reproductive organs and male and female mammary glands excellent as to vividity, accuracy and clarity. Most color plates show in addition pertinent histopathology as well as one or more x-ray pictures. All these color plates numbering 191 are accompanied by a comprehensive explanatory text written by research authorities such as Jacob Buckstein, Michael E. DeBakey, Charles F. Geschickter, Reuben A. MacBrayer, Henry H. Ritter, Eli H. Rubin, and Samuel A. West. The author himself is an outstanding medical artist, a member of both medical and art societies. Every practicing physician and specialist and their technical assistants will profit by the study of this unique collection of illustrations and text made possible by the generous understanding of a manufacturing concern and find it a ready reference.

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HANDBOOK OF MEDICAL MANAGEMENT. By *Milton Chatton*, A.B., M.D., Instructor in Medicine, University of California Medical School, San Francisco; *Sheldon Morgen*, A.B., M.D., Clinical Instructor in Medicine and Research Associate in Medicine, University of California Medical School, San Francisco; *Henry D. Brainerd*, A.B., M.D., Assistant Clinical Professor of Medicine and Pediatrics, University of California Medical School, San Francisco, Assistant Clinical Professor of Pediatrics, Stanford University School of Medicine, Physician in Charge, Isolation Division, San Francisco Hospital. First Edition. Paper. Pp. 476. Price, $3.00. University Medical Publishers, P. O. Box 761, Palo Alto, California, 1949.

This handbook summarizes in outline form the present day methods of medical management with a short description of the diagnostic symptoms, signs and laboratory findings. Diseases are listed by system and the book is well indexed for easy reference. Treatment is outlined quite completely with emphasis being placed on the more common diseases seen in medical practice. A separate chapter on the newer chemotherapeutic agents is included with actions, indications and contraindications, commonly used preparations, toxic manifestations and determination of dosage. An appendix describes the method, indications and dangers of various medical procedures such as blood transfusions, aerosol therapy for applicable lung diseases, maintenance of electrolyte and acid-base balance, etc. The authors plan a yearly revision so that newer therapeutic measures may be incorporated. This handbook is recommended for medical students and practicing physicians as a quick reference for medical treatment.

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A MANUAL OF BANDAGING, STRAPPING AND SPLINTING. By *Augustus Thorndike*, M.D., F.A.C.S., Associate in Surgery, Harvard Medical School; Chief Surgeon to the Department of Hygiene, Harvard University. Second Edition, with 119 illustrations. Pp. 148. Price, $2.00. Lea & Febiger, 600 S. Washington Sq., Philadelphia 6, 1950.

The common methods of applying bandages, strappings and splints are well expressed by the author. Because of the many drawings which represent plainly the technic of application, little is written descriptively. The author considers sterile and septic dressings of wounds, sprains, strains and contusions, dislocations and emergency splinting, transportation of fractures, and the use of plaster of paris in splinting. The modifications in the bibliography contain the only advance over the first edition. The manual may be recommended for physical therapists as well as medical students and nurses, and particularly those dealing with the prevention and after-care of athletic injuries.

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A YEAR WITH OSLER, 1896-1897. NOTES TAKEN AT HIS CLINICS IN THE JOHNS HOPKINS HOSPITAL. By *Joseph H. Pratt*, a member of the Class of 1898. Cloth. Pp. 209. Price, $4.00. The Johns Hopkins Press, Baltimore, Md., 1949.

A fascinating record of the expert medical teaching which explains why Osler is a name never to be forgotten. Besides being interesting reading for the historically minded, it should inspire physicians young and old to improve their diagnostic acumen through simple observation and examination of the patient. It seems assured that any physician will learn something useful for his practice during the few pleasurable hours spent reading this book.

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INFRARED RADIATION THERAPY SOURCES AND THEIR ANALYSIS WITH SCANNER. By *Leopold Rovner*, Consulting Physicist, Cambridge, Massachusetts. Leather. Price, $1.50. Pp. 34 with illustrations. Charles C Thomas, Publisher, 301-327 East Lawrence Avenue, Springfield, Ill., 1950.

This small book of 35 pages deals with a method devised by the author for measuring infrared radiation therapy sources.

It is of no interest to physicians from the standpoint of therapy, but does add to the general knowledge of instrumentation.

# PHYSICAL MEDICINE ABSTRACTS

**Depression of Tracer Ion Uptake Curve in Rat Erythrocytes Following Total Body X-Irradiation. Thomas G. Hennessy, and Rex. L. Huff.**

Proc. Soc. Exper. Biol. & Med. 73:436 (March) 1950.

The results obtained in these studies show that the radioactive iron red cell uptake curve is a sensitive indicator of x-irradiation damage to the bone marrow. They also confirm the histologic evidence of the sensitivity of erythroid tissue to x-irradiation. It appears that the greatest depression in erythroid marrow activity occurs at a period of about one day after the irradiation since the groups labeled at this period show a much greater depression at the 5 and 25 roentgen levels.

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**Electromyographic Patterns in Reinnervated Muscles. Melvin D. Yahr; Ernst Herz, and Joseph Moldaver.**

Federation Proc. 9:140 (March) 1950.

Electromyographic studies were carried out in a group of patients having complete peripheral nerve injuries with subsequent suture, three to five years prior to examination. Using a differential high gain condenser coupled amplifier, cathode ray oscillograph, and co-axial needle electrodes, two outstanding patterns were recorded: (1) spontaneous discharges below 1 mv. at rest with motor unit discharges of 500 uv. upon volitional contraction, (2) no spontaneous activity at rest, but, upon volitional contraction, large spikes varying in amplitude from 2 to 15 mv. These exhibited the characteristics of motor units; maintaining their amplitude, smooth contour and constant duration throughout a contraction, but varying in frequency with strength of contraction. When compared with potentials derived from normal muscles they were 20 to 30 times larger in amplitude. The first pattern was obtained from muscles giving only perceptible contraction and chronaxies 5 to 10 times normal value, the second from muscles with varying strengths of contraction but chronaxies within the normal range.

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**Recording Two-Channel Photofluorometer for in Vivo Studies with Fluorescein. David Minard, and Maynard Eicher.**

Federation Proc. 9:90 (March) 1950.

To measure time of appearance of fluorescein after intravenous injection and to record rate of change in fluorescence in 2 tissue areas simultaneously, a recording 2-channel photofluorometer has been constructed, each unit utilizing a photomultiplier tube (RCA 931A) as the photosensitive element and a GE F-5000 mercury vapor lamp as the ultraviolet source. The paired elements are fixed in either arm of a V-shaped holder with a one-inch window at the apex. For deeply situated organs, polished quartz rod extensions serve as 2-way conductors of activating ultraviolet and emitted fluorescence. Dark purple ultraviolet transmitting filters (Corning No. 5970) over the U-V sources and yellow filters (Corning No. 3486) over the photomultipliers, insure selective sensitivity to wavelengths emitted from activated fluorescein.

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**Relation of Length to Tension in Double-Function Muscles. J. E. Markee, and M. F. Williams.**

Federation Proc. 9:85 (March) 1950.

The authors have previously reported that those thigh muscles such as the gracilis, semitendinosus and biceps femoris which act as double muscles possess the physiologic characteristics of flexors in one part of the muscle and of extensors in the other part. That is, the flexor portion fatigues more rapidly, develops less tension per unit of weight, and develops effective tension through a larger proportion of the range of shortening of the fibers than does the extensor portion of the same muscle. The present study deals with further details of the ability of the flexor portion of these muscles and some of the flexor muscles which act over the ankle of the dog to develop effective tension through most of the range of movement, whereas the tension developed by the extensor portion of these muscles, or by adjacent extensors is markedly influenced by the length of fibers at the time of the contraction.

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**Blood pH and Blood-Flow During Muscular Activity. Klothilde Gollwitzer-Meier.**

Lancet 6601 (March 4) 1950.

According to the author one problem which has never been satisfactorily settled is the relation between blood pH and the blood-flow in an active muscle. The experiments are concerned with this question and the results show conclusively that the blood pH is not the sole or even the main factor responsible for the vascular reactions occurring in a muscle in situ during and after muscular activity.

Experiments were made on the dog's gastrocnemius muscle in situ with its normal circulation intact, but with every branch of the femoral artery and vein not going to, or coming from, the gastrocnemius carefully tied so that the blood in the femoral vein could be regarded as coming from the gastrocnemius only. The peripheral end of the cut sciatic nerve was stimulated electrically with alternating current from a Philips "Schwebungs-Oscillator" with a phase frequency of 100

hertz per sec. Submaximal contractions were obtained with a current intensity of 0.5-1 ma.

Two different groups of experiments were performed. In the first group the nerve was stimulated for a single period of two to sixty seconds to produce a single tetanic contraction. In the second group the nerve was stimulated every other second for three to eight minutes to produce a series of rhythmic tetanic contractions.

The discussion is limited to the experiments in which the muscle was stimulated every other second, because in this condition there was no phase in which the blood-flow became severely restricted by vascular compression. If we consider the time relations between the changes in blood-flow and blood pH in these experiments, it becomes clear that the increased blood-flow, which starts simultaneously with the first contractions and is then maintained at a steady level while the contractions last, cannot be the outcome of the changes in blood pH. It is doubtful whether the initial acidity plays more than an insignificant role in the increased blood-flow, and the subsequent alkalinity can certainly be of no consequence in the adaptation of the blood circulation to the requirements of the working muscle. Since the nerves were cut and the muscle was stimulated indirectly, proprioceptive reflexes are naturally excluded in our experiments. There remain thus only the following three possibilities to explain the initial vasodilatation: the effect of vasodilator metabolites; the massaging effect of the contracting muscle, and the activation of axon reflexes. These three factors may naturally work in unison.

**Unipolar Electromyograms of Patients with Dermatomyositis. E. H. Lambert; Sibyl Beckett; C. J. Chen, and L. M. Eaton.**

Federation Proc. 9:73 (March) 1950.

The electrical activity of muscle in 15 patients with dermatomyositis was detected with unipolar needle electrodes and recorded by a cathode-ray oscilloscope. In resting muscle, numerous potentials indistinguishable from a single-fiber potentials occurred spontaneously. There was also increased irritability to needle movement. In voluntary contraction, muscular weakness was associated primarily with a decrease in size (amplitude and duration), rather than in number of motor-unit action potentials, the latter, in some instances, approaching the appearance of single-fiber potentials.

**Dielectric Properties of Tissues Important in Microwave Diathermy. J. F. Herrick; D. G. Jelatis, and G. M. Lee.**

Federation Proc. 9:60 (March) 1950.

Microwave diathermy has become an integral part of medical diathermy since it was approved by the Council on Physical Medicine and Rehabilitation of the American Medical Association. This relatively new type of diathermy has proven to be an efficient method for heating certain localized areas of the body. The ultimate objective in studying the dielectric properties of animal tissues was to understand the heating of these tissues by microwaves. Observed values are presented for the dielectric constant and loss of freshly excised samples of such tissues as liver, muscle, fat, bone and bone marrow.

**Influence of Pulmonary Proprioceptive Reflexes During Electrophrenic Respiration. Paul O. Chatfield, and Stanley J. Sarnoff.**

Federation Proc. 9:22 (March) 1950.

During periodic stimulation of a phrenic nerve to produce descent of the diaphragm (electrophrenic respiration), one obtains an inhibition of spontaneous respiration which is clinically useful since it eliminates the conflict between the patient's spontaneous breathing and the imposed respiration. It has been shown that this inhibition can be brought about by vagal reflexes alone or secondarily by hyperventilation. In the present study, by recording muscle action potentials from the left (unstimulated) leaf of the diaphragm and from inspiratory intercostal muscles in dogs during application of electrophrenic stimulation to the right phrenic nerve, it was possible to ascertain the conditions of electrophrenic respiration which facilitate the desired inhibition of spontaneous respiration.

**Rheumatoid Arthritis. Dean Robinson.**

Canad. M. A. J. 61:152 (Aug.) 1949.

Rheumatoid arthritis is a constitutional disease, primarily affecting the periarticular structures. Carefully supervised exercises are commenced daily and at first the joints are moved through the full range of movement to the point of pain. Later as the soreness disappears and the condition improves, the patient is taught to do the exercises himself. Particular attention is paid to the quadriceps which is the important muscle in walking. Heat is a necessary form of therapy and though any form may be used, the warm deep pool is the most economical. The pool of mineral water has the advantage that the patient can do movements and even walk before he can stand on his feet on the floor. After the first week of rest, the patient is sent to the deep pool or the tub baths where the mineral water is kept at a temperature of 101 F. A basic formula of vitamins should be used in all cases, as most of these patients are undernourished and need building up. Gold is started as soon as the diagnosis is made and is continued for twenty-two doses if there is no contraindication.

**The Significance of Tinel's Sign in Peripheral Nerve Injuries. J. R. Napier.**

Brain 72:63 (March) 1949.

In 1915 Jules Tinel first described the "signe de fourmillent" as a tingling sensation produced in the cutaneous distribution of the nerve by percussion or compression of the nerve trunk over the site of the newly formed axis cylinders.

Tinel's sign is a valuable adjunct to the diagnosis and prognosis of peripheral nerve injuries. It is a constant sign and reliable if it is correctly interpreted, but it must be emphasized that its presence is not evidence that functional recovery will necessarily occur; it can only indicate the presence of regenerating sensory fibres. The behaviour of the sensory fibres may be used indirectly to make a rough assessment of the conditions prevailing at the site of the lesion. Tinel's sign may be the only positive evidence of activity of the nerve for many weeks after injury, and the advance information that it affords during this time is extremely valuable in planning the management of the case. A positive, advancing Tinel's sign should never be the criterion for withholding exploration if other evidence points to the presence of complete division. On the other hand, a negative sign after a suitable time has elapsed is the strongest possible evidence for exploration.

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**Painful Conditions of the Foot and Ankle. Philip Lewin.**

Postgraduate Med. **6**:202 (Oct.) 1949.

In a normal leg, a plumb line dropped from the center of the hip joint, through the middle of the patella, should bisect the leg and point to a spot between the first and second toes. In the pronated foot the line falls medialward, producing stress and strain, a defect which is bound to be followed by disability sooner or later.

The chief causes of flat feet are hereditary, static, traumatic, infectious, occupational, or glandular. Obesity is a very important factor, for whether it causes the flat feet or not, it aggravates them and keeps them painful.

The treatment of flat feet includes rest and local applications, walking properly, modification of shoes, supports, exercises, massage, contrast sprays and operation. The operations are chiefly closed manipulation and casts and open operations on bones and soft tissues.

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**The Care of Polio Patients Is a Job for the General Hospital. Joseph G. Molner.**

Mod. Hosp. **72**:56 (June) 1949.

In part, objection to the admission of poliomyelitis patients to general hospitals has been based upon the fact that adequately trained personnel and equipment have not been available. Modern methods of treatment of infantile paralysis do require special types of equipment and employment of physical therapists trained in the use of this equipment, as well as in application of modern therapeutic technics. With the recent realization of the important role of physical therapy in the treatment of disease, in both the acute and convalescent stages, it is virtually mandatory that every hospital have this service available. A well trained physical therapist should be in attendance and should be provided with adequate equipment, such as hot pack machines, sterilizers, treatment tables, wool and rubberized material for packs, and, of course, respirators and aspirators. Good physical therapists, with little additional training, can be indoctrinated in the use of this special poliomyelitis equipment and the application of modern therapeutic methods. The use of hot packs represent but a small part of the therapy regimen. Stretching and passive exercise, proper positions and supports and so-called "reeducation in physical movements of the patient" are probably more important. They are the usual responsibilities of physical therapists and are looked on by physicians as the most important aspect of modern infantile paralysis treatment.

There is no doubt in the minds of the majority of physicians, other professional groups, and hospital administrators that proper management of poliomyelitis requires the availability of the full facilities of a well organized, well staffed and well equipped hospital, that the staffs of these hospitals can be adequately trained in the care of poliomyelitis, and that equipment can be made available without a great deal of additional expense. There is no doubt in the minds of these groups that availability of immediate hospitalization is imperative and that long transportation to such facilities and the element of time involved multiply the risk to the patient in death and serious complications. If there is need for education of the hospital administrator in these facts, there probably is equally as great a need for education of the medical staff, nurses and lay personnel of institutions.

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**The Pathology of Hyperpyrexia Observations at Autopsy in 17 Cases of Fever Therapy. Ira Gore.**

Am. J. Path. **25**:1029 (Sept.) 1949.

Seventeen fatal cases of therapeutic hyperpyrexia have been reviewed to ascertain the nature of any pathologic changes that might have occurred. The underlying disease in each instance was of a type not usually associated with more than local tissue changes. Therefore except for the complicating factors considered in the text, morphologic alterations were regarded as the result of the controlled fever.

Congestion and purpuric hemorrhages were the rule. Patients who did not die within forty-eight hours after the fever also exhibited jaundice. Microscopically, necrosis of cells and other degenerative changes were observed in the brain, heart, liver, kidney, adrenal glands, and testes. The alterations, especially in the liver, were progressively more severe as the survival time increased. It is inferred that the absence of visible change when death is prompt merely expresses the limitations of current histologic technics.

Anoxia and deleterious effects of elevated temperature on essential cellular enzymes and enzyme reactions are probably the essential factors in producing these pathologic effects. Fever in many conditions besides pyretotherapy may produce similar lesions.

# PRELIMINARY PROGRAM

TWENTY-EIGHTH ANNUAL SCIENTIFIC SESSION

AND

INSTRUCTION SEMINAR

## American Congress of Physical Medicine

August 28, 29, 30, 31, and September 1, 1950

HOTEL STATLER — BOSTON

## SCHEDULE OF INSTRUCTION SEMINAR

### MONDAY, AUGUST 28

10:00 to 10:50—(A) **Neuro-Anatomy of the Brain and Spinal Cord.** CORBIN.

10:00 to 10:50—(1) **Recent Hormonal Investigations in Rheumatoid Arthritis.** POLLEY.

11:00 to 11:50—(B) **Neuro-Anatomy of the Brain and Spinal Cord.** CORBIN.

11:00 to 11:50—(2) **Recent Hormonal Investigations in Rheumatoid Arthritis.** POLLEY.

2:00 to 3:50—(C) **Pathologic Physiology of Lesions of the Brain (Types and Localizations Producing Motor Disturbances).** KARNOSH.

3:00 to 3:50—(3) **Physical Medicine in Rheumatoid Arthritis, in the Light of the New Treatment.** CLARK.

4:00 to 4:50—(D) **Pathologic Physiology of Lesions of the Spinal Cord (Localization of Lesions, Including Poliomyelitis).** KARNOSH.

4:00 to 4:50—(4) **The Clinical Use and Dangers of Microwave.** RAE.

### TUESDAY, AUGUST 29

8:30 to 9:20—(E) **Pathologic Physiology of Peripheral Nerve Lesions, Including the Neuritides.** DE LORME.

8:30 to 9:20—(5) **Analysis of Pathologic Gaits and Gait Training.** DEAVER.

9:30 to 10:20—(F) **The Physiologic Effects of Heat.** BIERMAN.

9:30 to 10:20—(6) **Resistive Exercises in the Treatment of Poliomyelitis.** SCHRAM.

### WEDNESDAY, AUGUST 30

8:30 to 9:20—(G) **Technic of Medical Writing.** HAMMOND.

8:30 to 9:20—(7) **Useful Mechanical Devices Used in Physical Medicine and Rehabilitation.** RUSSEK.

9:30 to 10:20—(H) **Technic of Medical Writing.** HAMMOND.

9:30 to 10:20—(8) **Exercise in the Treatment of Asthma.** FRANCES BAKER.

### THURSDAY, AUGUST 31

8:30 to 9:20—(J) **Physics of Muscular Action.** LION.

8:30 to 9:20—(9) **Indications for Orthopedic Reconstruction in Poliomyelitis.** GREEN.

9:30 to 10:20—(K) **Physics of Muscular Action.** LION.

9:30 to 10:20—(10) **Disabilities of the Shoulder.** KOTTKE.

## LECTURERS FOR INSTRUCTION SEMINAR

**FRANCES BAKER, M.D.**, San Mateo, Calif.;

**WILLIAM BIERMAN, M.D.**, Assistant Clinical Professor in Medicine, Columbia University, New York, N. Y.;

**WILLIAM S. CLARK, M.D.**, Instructor in Medicine, Harvard Medical School, Boston, Mass.;

**KENDALL B. CORBIN, M.D.** (by invitation), Associate Director, Mayo Foundation, Rochester, Minn.;

**GEORGE G. DEAVER, M.D.**, Professor of Clinical Rehabilitation and Physical Medicine, New York University College of Medicine, New York, N. Y.;

**THOMAS DE LORME, M.D.** (by invitation), Assistant in Physical Medicine, Massachusetts General Hospital, Boston, Mass.;

**WILLIAM T. GREEN, M.D.** (by invitation), Clinical Professor of Orthopedic Surgery, Harvard Medical School, Boston, Mass.;

**JOHNSON F. HAMMOND, M.D.** (by invitation), Assistant Editor, The Journal of the American Medical Association, Chicago, Ill.;

**LOUIS J. KARNOSH, M.D.** (by invitation), Clinical Professor of Neurology, Western Reserve University; Head, Neuropsychiatry, Cleveland Clinic, Cleveland, Ohio;

**FREDERIC J. KOTTKE, M.D.**, Associate Professor, Division of Physical Medicine, University of Minnesota Hospitals, Minneapolis, Minn.;

**KURT S. LION, Ph.D.** (by invitation), Associate Professor of Applied Biophysics, Department of Biology, Massachusetts Institute of Technology, Cambridge, Mass.;

**HOWARD F. POLLEY, M.D.**, Instructor in Medicine, Graduate School, University of Minnesota, Mayo Foundation, Rochester, Minn.;

**JAMES W. RAE, JR., M.D.**, Assistant Professor of Physical Medicine and Rehabilitation, University of Michigan Medical School, Ann Arbor, Mich.;

**ALLEN S. RUSSEK, M.D.** (by invitation), Assistant Professor, Department of Physical Medicine and Rehabilitation, New York University, New York, N. Y.;

**DUANE A. SCHRAM, M.D.** (by invitation), Department of Physical Medicine, Gonzales Warm Springs Foundation, Gonzales, Tex.

## GENERAL INFORMATION

### RULES GOVERNING THE READING OF PAPERS

No paper or address before the Congress shall occupy more than fifteen minutes in its delivery. The program is so arranged that all the time is utilized and it is therefore imperative that the stated time schedule is closely followed.

All papers read before the Congress shall be the property of the Congress for publication in the official journal. Each paper shall be deposited with the secretary of the section when read.

### THE CONVENTION

The registration desk will be open at 10:00 a. m., Sunday, August 27 for preconvention registration. It is important that everyone register before entering the lecture hall. Those not wearing the official badge will be refused admission. This meeting is not open to the public. No registration fee will be charged.

Date

# APPLICATION FOR INSTRUCTION SEMINAR

**In Conjunction with the**
**28th Annual Scientific and Clinical Session**
**of the**
**AMERICAN CONGRESS OF PHYSICAL MEDICINE**
**August 28, 29, 30 and 31, 1950**
**Hotel Statler, Boston, Massachusetts**

Name
(Please print)

Address
(Please print)

(If physician, please answer)

Member A.M.A. Member County Medical Society

(Give Name)

If Government Service state briefly

(If therapist, please answer)
Note: The members in good standing of the American Registry of Physical Therapy Technicians, or the American Occupational Therapy Association are eligible to attend.)

(Signature in Ink)

**Please make check payable to and mail with application to**

**American Congress of Physical Medicine**
**30 North Michigan Avenue Chicago 2, Illinois**

## BUSINESS SESSIONS

The annual business meetings for the members of the Congress will be held Monday, August 28, at 8:00 p. m., in Parlor B, and on Tuesday, August 29, at 4:30 p. m., in the Ballroom Assembly.

## CONGRESS DINNER

The annual Congress dinner will be held on Wednesday evening, August 30 at 7:00 p. m., in the Bay State Room and dress is optional. Exhibitors and guests are welcome. An interesting but brief after-dinner program has been arranged. You will enjoy this occasion, the only social function of the convention.

## THE INSTRUCTION SEMINAR

Courses are offered in two separate groups: One group, designated by letters, consists of ten lectures on basic subjects. Physicians only will be permitted to register for this group of lectures. A second group of ten lectures, designated by numerals, will present more general and clinical subjects. Physicians as well as physical therapists who are registered with the American Registry of Physical Therapy Technicians will be permitted to register for these courses. Note: Members in good standing of the American Occupational Therapy Association are eligible to enroll for the instruction course.

The instruction course will be given from 10:00 to 10:50 and 11:00 to 11:50, Monday morning, August 28; from 3:00 to 3:50 and 4:00 to 4:50, Monday afternoon, August 28. It will continue at 8:30 to 9:20, and 9:30 to 10:20, the mornings of Tuesday, August 29; Wednesday, August 30 and Thursday, August 31. This schedule will enable attendance at both the course and scientific sessions.

Each registrant for the course is allowed the choice of one lecture during a period. The charge for the complete schedule of ten lectures is $15.00. Less than ten lectures may be scheduled at $2.00 per lecture. The right is reserved to reject any application if the Course Committee finds it desirable to do so. Registration for specific courses cannot be guaranteed when quotas are filled.

Those who have not completed their registration for the course should do so before attending any of the lectures. No one will be admitted to any of the course lectures without the official registration card for the course. Registration for the course may be completed on Sunday, August 27, starting at 10:00 a. m., and continuing throughout the week starting at 8:00 a. m. at the main registration desk of the Congress.

## AMERICAN SOCIETY OF PHYSICAL MEDICINE

The American Society of Physical Medicine will hold its annual meeting, dinner, 7:00 p. m., in Parlor A, Tuesday, August 29.

## EDUCATIONAL CONFERENCE

An entire day has been set aside for the Educational Conference which is open to members of the Congress and others by invitation. The Conference will convene at 10:00 a. m., Monday, August 28, in Parlor A of the Hotel Statler; at 12:30 noon, there will be a luncheon meeting of the Advisory Committee on Education to the Council on Physical Medicine and Rehabilitation, in Parlor D. This function is by invitation. The general conference will be resumed in Parlor A at 2 p. m.

## SCIENTIFIC EXHIBITS

Scientific exhibits will be on display again and should prove of great interest. As was the custom formerly, medals will be awarded to those exhibits which are adjudged the outstanding ones by the committee on scientific awards and will be announced at the annual Congress dinner.

## TECHNICAL EXHIBITS

The program of the scientific sessions and instruction seminar has been arranged with intermission periods to give time for visits and inspection of the technical exhibits. As these exhibits have been arranged with considerable effort, we urge every member and guest to set aside sufficient time for a complete tour of all exhibits. Exhibits will be open from 9:00 a. m., to 5:00 p. m., Tuesday, August 29, Wednesday, August 30 and until 2:30 p. m., Thursday, August 31.

## EDITORIAL BOARD

The annual meeting of the Editorial Board will be held Tuesday, August 29, 8:30 a. m., Breakfast, Parlor E.

## AMERICAN REGISTRY OF PHYSICAL THERAPY TECHNICIANS

The annual meeting of the Boards of the Registry will be held Thursday, August 31, 12:30 p. m., luncheon, Parlor D.

### VETERANS ADMINISTRATION

There will be a luncheon meeting for physiatrists, attendants and consultants in Physical Medicine and Rehabilitation for the Veterans Administration in Bay State Room, Hotel Statler, Wednesday, August 30, 12:15 P. M. There will be a short program and discussion. Please contact Dr. A. B. C. Knudson for final arrangements and tickets.

### HYDROTHERAPY GROUP

There will be a luncheon meeting for the group interested in hydrotherapy on Wednesday, August 30, 12:30 P. M. Hotel Statler, Parlor D (by invitation).

### COMMITTEE ON COOPERATION WITH FOOD AND DRUG ADMINISTRATION

There will be a luncheon meeting of the Committee on Cooperation with the Food and Drug Administration on Wednesday, August 30, 12:30 P. M., Parlor E, Hotel Statler (by invitation).

## SCHEDULE OF DAILY ACTIVITIES

## 28TH ANNUAL SESSION

### SUNDAY, August 27

10:00–2:00 Registration.

### MONDAY, August 28

8:00 A.M. Registration.
10:00 A.M. Instruction Seminar, Parlor B.
10:00 A.M. Instruction Seminar, Parlor C.
10:00 A.M. Educational Conference, Parlor A.
11:00 A.M. Instruction Seminar, Parlor B.
11:00 A.M. Instruction Seminar, Parlor C.
12:30 Noon Luncheon, Advisory Committee on Education, Hancock Room (by invitation).
2:00 P.M. Educational Conference, Parlor A.
3:00 P.M. Instruction Seminar, Parlor B.
3:00 P.M. Instruction Seminar, Parlor C.
4:00 P.M. Instruction Seminar, Parlor B.
4:00 P.M. Instruction Seminar, Parlor C.
4:00 P.M. Board of Governors, Congress, Parlor F.
6:00 P.M. Executives Dinner, Hancock Room (by invitation).
8:00 P.M. Annual Congress Business Meeting, First Session — Congress Members only, Parlor B.

### TUESDAY, August 29

8:00 A.M. Registration — Inspection of Exhibits.
8:30 A.M. Instruction Seminar, Parlor B.
8:30 A.M. Instruction Seminar, Parlor C.
8:30 A.M. Editorial Board Breakfast, Parlor E (by invitation).
9:30 A.M. Instruction Seminar, Parlor B.
9:30 A.M. Instruction Seminar, Parlor C.
10:30 A.M. Scientific Program, Ballroom Assembly.
10:30 A.M. Scientific Program, Parlor A.
12:00 Noon Luncheon and Inspection of Exhibits.
2:00 P.M. Formal Opening Session, Ballroom Assembly.
4:30 P.M. Annual Congress Business Meeting, Second Session — Congress Members only, Ballroom Assembly.
5:30 P.M. American Society of Physical Medicine — Board of Governors, Parlor F.
7:00 P.M. Dinner Meeting — American Society of Physical Medicine, Members only, Parlor A.

### WEDNESDAY, August 30

8:00 A.M. Registration — Inspection of Exhibits.
8:30 A.M. Instruction Seminar, Parlor B.
8:30 A.M. Instruction Seminar, Parlor C.
9:30 A.M. Instruction Seminar, Parlor B.
9:30 A.M. Instruction Seminar, Parlor C.
10:30 A.M. Scientific Program, Ballroom Assembly.
10:30 A.M. Scientific Program, Parlor A.
12:00 Noon Luncheon and Inspection of Exhibits.
12:15 P.M. Luncheon Meeting, VA Group, Bay State Room (by invitation).
12:30 P.M. Luncheon Meeting, Hydrotherapy Group, Parlor D (by invitation).
12:30 P.M. Luncheon Meeting, Food and Drug Committee, Parlor E (by invitation).
2:00 P.M. Scientific Program, Ballroom Assembly.
7:00 P.M. Annual Congress Dinner, Bay State Room.

### THURSDAY, August 31

8:00 A.M. Registration — Inspection of Exhibits.
8:30 A.M. Instruction Seminar, Parlor B.
8:30 A.M. Instruction Seminar, Parlor C.
9:30 A.M. Instruction Seminar, Parlor B.
9:30 A.M. Instruction Seminar, Parlor C.
10:30 A.M. Scientific Program, Ballroom Assembly.
10:30 A.M. Scientific Program, Parlor A.
12:00 Noon Luncheon and Inspection of Exhibits.
12:00 Noon Registry Board Luncheon, Parlor D (by invitation).
2:00 P.M. Scientific Program, Georgian Room.

### FRIDAY, September 1

9:30 A.M. Scientific Program, Parlor A.
9:30 A.M. Scientific Program, Parlor C.
1:00 P.M. Baruch Luncheon and Meeting, Parlor C (by invitation).

## GENERAL SCIENTIFIC SESSION

**Sponsored by the American Society of Physical Medicine**

### TUESDAY, August 29 — 10:30 A. M.

**Ballroom Assembly**

OFFICERS OF THE SECTION

Chairman — GORDON MARTIN, Rochester, Minn.
Secretary — MAIDE C. L. MCGUINNESS, New York, N. Y.

SYMPOSIUM ON PHYSIOLOGY

**10:30 Muscle Tension Following Electrical Stimulation to Muscles.**

JEROME W. GERSTEN, M.D., Assistant Professor, Department of Physical Medicine and Rehabilitation, University of Colorado Medical Center, Denver, Colo.

**10:45 The Vascular Reaction to Exercise in Normal Man.**

MILTON LOWENTHAL, M.D., Assistant Attending in Physical Medicine, Montefiore Hospital, New York, N. Y.

and

KARL HARPUDER, M.D., Assistant Clinical Professor of Medicine, College of Physicians and Surgeons, Columbia University, New York, N. Y.

**11:10 The Effect of Maintained Contracture Upon the Physiological Properties of Muscle.**

ERNST FISCHER, M.D., Research Professor of Physiology, Department of Physiology, Medical College of Virginia,

and

HELEN V. SKOWLUND, M.S. (by invitation), Research Associate, Department of Physiology, Medical College of Virginia, Richmond, Va.

**11:30 Objective Recording of the Strength of Normal Muscles.**

EARL C. ELKINS, M.D., Section on Physical Medicine, Mayo Clinic,

URSULA M. LEDEN, M.D., Fellow in Physical Medicine, Mayo Foundation,

and

KHALIL G. WAKIM, M.D., Ph.D. (by invitation), Professor of Physiology and Research Consultant to the Section on Physical Medicine, Mayo Foundation, Rochester, Minn.

Discussion of foregoing papers: Robert Boyle, M.D., Fort Thomas, Ky.

11:50 **The Influence of Physical Agents, Vasodilator and Vasoconstrictor Drugs on Intra- and Juxta-articular Temperatures.**

KHALIL G. WAKIM, M.D., Ph.D. (by invitation), Professor of Physiology and Research Consultant to the Section on Physical Medicine, Mayo Foundation,

and

ADRIEN PORTER (by invitation), Technical Assistant, Department of Physiology, Mayo Foundation, Rochester, Minn.

Discussion: Joseph Hollander, M.D., Philadelphia, Pa.

12:10 **Tissue Release Treatment in Related Zones.**

HANS J. BEHREND, M.D., Associate in Physical Medicine, Hospital for Joint Diseases, New York, N. Y.

Discussion: James W. Rae, Jr., M.D., Ann Arbor, Mich.

## GENERAL SCIENTIFIC SESSION

### TUESDAY, August 29 — 10:30 A. M.

### Parlor A

OFFICERS OF THE SECTION

Chairman — George M. Piersol, Philadelphia, Pa.
Secretary — Ben L. Boynton, Houston, Texas.

SYMPOSIUM ON CEREBRAL PALSY

10:30 **Common Deformities in Cerebral Palsy.**

HARRIET E. GILLETTE, M.D., Cerebral Palsy Consultant, National Society for Crippled Children and Adults, Atlanta, Ga.

10:45 **The Organization of a Clinic for the Treatment and Study of Children with Cerebral Palsy.**

DAVID MCL. GREELEY, M.D. (by invitation), Instructor, Department of Pediatrics, College of Physicians and Surgeons, Columbia University, New York, N. Y.

11:00 **Treatment of Cerebral Palsy: Clinical Analysis of the Use of Anti-spastic Drugs.**

MORTON HOBERMAN, M.D., Consultant in Physical Medicine, New York State Rehabilitation Hospital, New York, N. Y.

Discussion of foregoing papers: George Deaver, M.D., New York, N. Y.; Frederic B. House, M.D., Ann Arbor, Mich.

11:30 **Observations and Effects of Low Frequency Currents in Spastic and Hyperkinetic Disorders.**

MAX K. NEWMAN, M.D., Director, Physical Medicine and Rehabilitation, Grace Hospital, Detroit, Mich.

and

LEWIS COHEN, M.D., Grace Hospital, Detroit, Mich.

Discussion: Louis B. Newman, M.D., Hines, Ill.

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11:50 **The Sweating Test for Sympathectomy.**

HARRY T. ZANKEL, M.D., Chief, Physical Medicine Rehabilitation, Cole Veterans Administration Hospital, Cleveland, Ohio.

12:10 **Evaluation and Treatment of Vascular Diseases (with special consideration of plethysmography).**

ARTHUR E. WHITE, M.D., Chief, Physical Medicine Service, Letterman General Hospital, San Francisco, Calif.

Discussion of foregoing papers: Harry Bouman, M.D., Madison, Wis.

## GENERAL SCIENTIFIC SESSION

### TUESDAY, August 29 — 2:00 P. M.

### Ballroom Assembly

OFFICERS OF THE SECTION

Chairman — Earl C. Elkins, Rochester, Minn.
Secretary — Richard Kovacs, New York, N. Y.

## FORMAL OPENING OF THE 28TH ANNUAL SESSION

INVOCATION

The Reverend Dana M. Greeley
Rector, Arlington Street Church, Boston.

ADDRESSES OF WELCOME

Dwight O'Hara, M.D.
Dean, Tufts College Medical School.

Leland S. McKittrick, M.D.
President, Massachusetts Medical Society.

INDUCTION OF PRESIDENT ELECT

ADDRESS

2:30 **Boundaries of Physical Medicine.**

ARTHUR L. WATKINS, M.D., Boston, Mass.

3:00 **Significance to the Physiatrist of Recent Developments in Rheumatic Disease.**

HOWARD F. POLLEY, M.D., Consultant in Medicine, Section on Rheumatic Diseases, Mayo Clinic, Rochester, Minn.

Discussion: Walter M. Solomon, M.D., Cleveland, Ohio.

3:20 **The Measurement of Fitness as a Problem of Physical Medicine.**

FREDERIC T. JUNG, M.D., Assistant Secretary, Council on Physical Medicine and Rehabilitation, American Medical Association, Chicago, Ill.

Discussion: Michael Dacso, M.D., New York, N. Y.

3:40 **Electrophrenic Respiration.**

STANLEY J. SARNOFF, M.D. (by invitation), Assistant Professor of Physiology, Harvard School of Public Health, Boston, Mass.

Discussion: Frederic J. Kottke, M.D., Minneapolis, Minn.

4:00 **Scientific Medical Writing.**

JOHNSON E. HAMMOND, M.D. (by invitation), Associate Editor, *The Journal of the American Medical Association*, Chicago, Ill.

Discussion: Richard Kovacs, M.D., New York, N. Y.

4:20 **The Important Legislative Problems in the Expanding Field of Physical Medicine and Rehabilitation.**

NILA KIRKPATRICK COVALT, M.D., Chief of Physical Medicine and Rehabilitation, Hospital for Chronic Illness, Rocky Hill, Conn.

Discussion: Madge C. L. McGuinness, M.D., New York, N. Y.

## GENERAL SCIENTIFIC SESSION

**Sponsored by the American Society of Physical Medicine**

**WEDNESDAY, August 30 — 10:30 A. M.**

**Ballroom Assembly**

OFFICERS OF THE SECTION

Chairman — WILLIAM BIERMAN, New York.
Secretary — MILTON SCHMITT, Chicago.

SYMPOSIUM ON ELECTROMYOGRAPHY

**10:30 Progress Report on Research in Electromyography.**

H. WORLEY KENDELL, M.D., Head of Department of Physical Medicine and Rehabilitation, Research and Educational Hospitals of the University of Illinois College of Medicine,

and

ARTHUR A. RODRIQUEZ, M.D., Department of Physical Medicine and Rehabilitation, University of Illinois College of Medicine, Chicago, Ill.

**10:45 Electromyography in the Evaluation of Therapeutic Measures.**

WILLIAM BIERMAN, M.D., Assistant Clinical Professor in Medicine, College of Physicians and Surgeons, Columbia University, New York, N. Y.

**11:00 Electromyographic Studies on the Mechanism of Spasticity.**

ARTHUR S. ABRAMSON, M.D., Chief, Physical Medicine Rehabilitation Service, Veterans Administration Hospital, Bronx, N. Y.,

and

GERALD G. HIRSCHBERG, M.D., Fellow in Physical Medicine and Rehabilitation, New York University College of Medicine, New York, N. Y.

**11:15 Electromyography of Fatigue.**

G. CLINTON KNOWLTON, Ph.D. (by invitation), Department of Physical Medicine, Emory University Medical School, Emory University, Ga.,

and

ROBERT L. BENNETT, M.D., Director of Physical Medicine, Georgia Warm Springs Foundation, Professor Physical Medicine, Emory University Medical School; Warm Springs, Ga.

**11:30 Diagnostic Features of Electromyography**

O. LEONARD HUDDLESTON, M.D., Director, Department of Physical Medicine, Los Angeles County General Hospital, Los Angeles, Medical Director, Kabat-Kaiser Institute, Santa Monica, Calif.

**11:45 The Analysis of Muscle Action Potentials in the Differential Diagnosis of Neuromuscular Diseases.**

ARTHUR T. RICHARDSON, D. Phys. Med. (by invitation), Physical Medicine Department, St. Thomas' Hospital, Westminster, London, England.

Discussion of foregoing papers: Arthur A. Rodriquez, M.D., Chicago, Ill.; Joshua Ehrlich, M.D., Louisville, Ky.

## GENERAL SCIENTIFIC SESSION

**WEDNESDAY, August 30 — 10:30 A. M.**

**Parlor A**

OFFICERS OF THE SECTION

Chairman — WALTER MCCLELLAN, Saratoga Springs, N. Y.
Secretary — ISADORE LEVIN, Washington, D. C.

**10:30 Some Physiologic Aspects of Progressive Resistance Exercise.**

THOMAS L. DELORME, M.D. (by invitation), Assistant in Physical Medicine, Massachusetts General Hospital, Boston, Mass.

Discussion: Major Joseph N. Schaeffer, MC, El Paso, Texas.

**10:50 The Function of the Quadratus Lumborum.**

MILAND E. KNAPP, M.D., Clinical Professor of Physical Medicine, University of Minnesota Medical School, Minneapolis, Minn.

Discussion: Oscar O. Selke, M.D., Houston, Texas.

SYMPOSIUM ON HYDROTHERAPY

**11:10 Electrically Heated Hot Packs.**

ALEX HARELL, M.D., Division of Physical Medicine, Washington University School of Medicine;

SEDGWICK MEAD, M.D., Assistant Professor and Head of Division of Physical Medicine, Washington University School of Medicine,

and

EMILY E. MUELLER, M.S. (by invitation), Division of Physical Medicine, Washington University School of Medicine, St. Louis, Mo.

**11:25 Hot Packing.**

FRANCIS X. SWEENEY, M.D., Instructor in Physical Medicine, Graduate School of Medicine, University of Pennsylvania,

and

EMERY K. STONER, M.D. (by invitation), Assistant Instructor in Physical Medicine, Department of Physical Medicine and Rehabilitation, Graduate School of Medicine, University of Pennsylvania, Philadelphia, Pa.

**11:40 The Evaluation of Health Resorts.**

HOWARD A. CARTER, M.E., Secretary, Council on Physical Medicine and Rehabilitation, American Medical Association, Chicago.

Discussion of foregoing papers: John D. Currence, M.D., New York City and Samuel A. Warshaw, M.D., Brooklyn, N. Y.

## ANNUAL CONGRESS DINNER

**INFORMAL**

**WEDNESDAY, August 30 — 7:00 P. M.**

**Bay State Room**

TOASTMASTER: ARTHUR L. WATKINS, M.D.
*President*

**SPEAKER**

NATHANIEL W. FAXON, M.D.
Director Emeritus, Massachusetts General Hospital, Boston, Mass.

**AWARDS**

WALTER M. SOLOMON, M.D.
Chairman, Committee, Gold Key Awards

ROBERT W. BOYLE, M.D.
Chairman, Committee, Scientific Exhibits

## GENERAL SCIENTIFIC SESSION

**WEDNESDAY, August 30 — 2:00 P. M.**

**Ballroom Assembly**

OFFICERS OF THE SECTION

Chairman — Sidney Licht, Cambridge, Mass.
Secretary — Nicholas D. Mauriello, Wilkes-Barre, Pa.

SYMPOSIUM ON OCCUPATIONAL THERAPY

**2:00 Economical Factors Involved in the Occupational Therapy Program of a General Hospital.**

WILLIAM B. SNOW, M.D., Associate Professor of Physical Medicine, College of Physicians and Surgeons, Columbia University, New York, N. Y.

**2:15 Occupational Therapy in a General Medical and Surgical Hospital.**

CHARLES O. MOLANDER, M.D., Director, Department of Physical Medicine, Michael Reese Hospital, Chicago, Ill.

**2:30 How Occupational Therapy Helps in a Psychiatric Hospital.**

WINFRED OVERHOLSER, M.D. (by invitation), Professor of Psychiatry, George Washington University School of Medicine, Washington, D. C.,

and

VIRGINIA D. COFFIN, B.S. (by invitation), Assistant Chief Occupational Therapist, St. Elizabeth's Hospital, Washington, D. C.

**2:45 A Functional Program for the Treatment of Hand Disabilities in Rheumatoid Arthritis.**

DONALD L. ROSE, M.D., Associate Professor of Physical Medicine, University of Kansas School of Medicine, Kansas City, Kansas,

and

LAVERNA J. WALLACE, O.T.R., B.S. in O.T. (by invitation), Director of Occupational Therapy, University of Kansas Medical Center, Kansas City, Kansas.

**3:00 Reasons for Failures in Functional Occupational Therapy.**

SEDGWICK MEAD, M.D., Assistant Professor and Head of Division of Physical Medicine, Washington University School of Medicine, St. Louis, Mo.

SYMPOSIUM ON BRACES

**3:30 Principles Underlying Prescription of Braces.**

JESSIE WRIGHT, M.D., Medical Director, D. T. Watson School of Physiatrics, affiliated with the University of Pittsburgh School of Medicine, Pittsburgh, Pa.

**3:45 Functional Apparatus.**

ROBERT L. BENNETT, M.D., Director of Physical Medicine, Georgia Warm Springs Foundation, Professor Physical Medicine, Emory University Medical School; Warm Springs, Ga.

**4:00 Fitting and Alignment of Braces for Lower Extremities.**

ODON F. VON WERSSOWETZ, M.D., Chief, Physical Medicine Rehabilitation Service, Thayer Veterans Administration Hospital, Nashville, Tenn.

Discussion of foregoing papers: Herman J. Flax, M.D., Santurce, P. R., and Irving Tepperberg, M.D., Bronx, N. Y.

## GENERAL SCIENTIFIC SESSION

**Sponsored by the American Society of Physical Medicine**

**THURSDAY, August 31 — 10:30 A. M.**

**Ballroom Assembly**

OFFICERS OF THE SECTION

Chairman — William D. Paul, Iowa City, Ia.
Secretary — Arthur Peck, Atlanta, Ga.

SYMPOSIUM ON ULTRASONICS

**10:30 An Experimental Study of Temperature Produced in Bone Marrow, Bone and Adjacent Tissues by Ultrasonics Diathermy.**

PAUL A. NELSON, M.D., Fellow in Physical Medicine, Mayo Foundation;

JULIA F. HERRICK, Ph.D. (by invitation), Associate Professor, Experimental Medicine, Institute of Experimental Medicine, Mayo Foundation,

and

FRANK H. KRUSEN, M.D., Professor of Physical Medicine, Mayo Foundation and Head of Section on Physical Medicine, Mayo Clinic, Rochester, Minn.

**10:45 An Experimental Study of Effects of Ultrasonics on the Lower Spinal Cord and Peripheral Nerves.**

THOMAS P. ANDERSON, M.D., Fellow in Physical Medicine, Mayo Foundation;

KHALIL G. WAKIM, M.D., Ph.D. (by invitation), Professor of Physiology and Research Consultant to the Section on Physical Medicine, Mayo Foundation;

JULIA F. HERRICK, Ph.D. (by invitation), Associate Professor of Experimental Medicine, Institute of Experimental Medicine, Mayo Foundation,

and

FRANK H. KRUSEN, M.D., Professor of Physical Medicine, Mayo Foundation and Head of Section on Physical Medicine, Mayo Clinic, Rochester, Minn.

**11:00 Effects of Ultrasound on the Growing Ends of Long Bones.**

RALPH F. DEFOREST, M.D., Fellow in Physical Medicine, Mayo Foundation;

JOSEPH M. JANES, M.D. (by invitation), Section on Orthopedic Surgery, Mayo Clinic;

JULIA F. HERRICK, Ph.D. (by invitation), Associate Professor of Experimental Medicine, Institute of Experimental Medicine, Mayo Foundation,

and

FRANK H. KRUSEN, M.D., Professor of Physical Medicine, Mayo Foundation and Head of Section on Physical Medicine, Mayo Clinic, Rochester, Minn.

**11:15 Histopathology of Tissues Exposed to Ultrasound.**

WARREN A. BENNETT, M.D. (by invitation), Assistant Professor of Pathology, Mayo Foundation, Consultant in Section on Pathology, Mayo Clinic;

JULIA F. HERRICK, Ph.D. (by invitation), Associate Professor of Experimental Medicine, Institute of Experimental Medicine, Mayo Foundation,

and

FRANK H. KRUSEN, M.D., Professor of Physical Medicine, Mayo Foundation and Head of Section on Physical Medicine, Mayo Clinic, Rochester, Minn.

Discussion of foregoing papers: Howard A. Carter, Chicago, Ill., and William Bierman, M.D., New York, N. Y.

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**11:45 Heating of the Maxillary Sinus by Microwaves.**

STAFFORD L. OSBORNE, Ph.D. (by invitation), Chairman and Professor, Department of Physical Medicine, Northwestern University Medical School, Chicago, Ill.

**12:00 Essential Factors in Crystal Control Diathermy Treatment.**

DISRAELI W. KOBAK, M.D., Chairman, Department of Physical Medicine, Cook County Hospital, Chicago, Ill.

Discussion of foregoing papers: Fred Moor, M.D., Los Angeles, Calif.

## GENERAL SCIENTIFIC SESSION

### THURSDAY, August 31 — 10:30 A. M.

### Parlor A

OFFICERS OF THE SECTION

Chairman — Fred B. Moor, Los Angeles, Calif.
Secretary — George D. Wilson, Asheville, N. C.

**10:30 The Physical Management of Dupuytren's Contracture.**

HAROLD V. CRANFIELD, M.D. (by invitation), Medical Director of Mutual Benefit Health and Accident Association, Toronto, Canada.

Discussion: Herbert W. Park, M.D., Fort Thomas, Ky.

**10:50 The Physical Treatment of the Industrially Injured Hand.**

LEONARD J. YAMSHON, M.D., Instructor in Physical Medicine, College of Medical Evangelists, Los Angeles, Calif.

Discussion: Isadore Levin, M.D., Washington, D. C.

**11:10 The Costo-Clavicular Syndrome.**

SHELBY G. GAMBLE, M.D., Director of Physical Medicine, Cleveland Clinic, Cleveland, Ohio.

Discussion: Bror S. Troedsson, M.D., Orange, N. J.

**11:30 Combined Use of Cortisone and Rehabilitation Technics in Certain Arthritis Problems.**

JAMES A. COSS, JR., M.D. (by invitation), Assistant in Medicine, College of Physicians and Surgeons, Columbia University, New York, N. Y.,

and

CHARLES RAGAN, M.D. (by invitation), Assistant Professor of Medicine, Department of Medicine, College of Physicians and Surgeons, Columbia University, New York, N. Y.

Discussion: Robert M. Stecher, M.D., Cleveland, Ohio.

**11:50 Post-Thoracoplasty Scoliosis.**

RALPH E. DWORK, M.D. (by invitation), Chief, Division of Tuberculosis, State of Ohio, Department of Health, Columbus, Ohio;

HAROLD DINKEN, M.D., Professor and Head, Department of Physical Medicine and Rehabilitation, University of Colorado School of Medicine and Hospitals, Denver, Colo.,

and

ALLAN HURST, M.D. (by invitation), Assistant Professor of Medicine, University of Colorado School of Medicine and Hospitals, Denver, Colo.

Discussion: Bert A. Treister, M.D., Cleveland, Ohio.

**12:10 Craniofacial Pain in Cervical Disk Protrusion: Treatment by Physical Means.**

EUGENE NEUWIRTH, M.D., Department of Physical Medicine, Mount Sinai Hospital, New York, N. Y.,

and

KENNETH M. GANG, M.D. (by invitation), Assistant in Neurology, College of Physicians and Surgeons, Columbia University, New York, N. Y.

Discussion: Ray Piaskoski, M.D., Milwaukee, Wis.

## GENERAL SCIENTIFIC SESSION

### THURSDAY, August 31 — 2:00 P. M.

### Georgian Room

OFFICERS OF THE SECTION

Chairman — William H. Schmidt, Philadelphia, Pa.
Secretary — Herman L. Rudolph, Reading, Pa.

SYMPOSIUM ON REHABILITATION

**2:00 Rehabilitation Frontiers in Physical Medicine.**

CHARLES L. NEWBERRY, M.D. (by invitation), Senior Surgeon, U. S. Public Health Service, assigned as Assistant Chief Medical Officer, Office of Vocational Rehabilitation, Washington, D. C.

**2:15 Rehabilitation of the Severely Disabled.**

HENRY H. KESSLER, M.D. (by invitation), Medical Director, Kessler Institute for Rehabilitation, West Orange, N. J.

**2:30 Civilian Rehabilitation in a Center and in the Community (with special reference to economic considerations).**

JOSEPHINE J. BUCHANAN, M.D., Assistant Professor of Clinical Physical Medicine, Medical College of Virginia, Richmond, Va.

Discussion of foregoing papers: A. B. C. Knudson, M.D., Washington, D. C.

**3:00 Rehabilitation of Civilian Paraplegics in Canadian Department of Veterans' Affairs Hospitals.**

GUSTAVE GINGRAS, M.D., Director of Physical Medicine, Department of Veterans Affairs, Montreal, Canada.

**3:15 Management of Decubitus Ulcers in the Paraplegic Patient.**

CHARLES S. WISE, M.D., Associate Professor, Department of Physical Medicine, The George Washington University School of Medicine;

WILLIAM C. MELOY, M.D. (by invitation), Associate in Surgery, The George Washington School of Medicine, Washington, D. C.,

and

GORDON S. LETTERMAN, M.D. (by invitation), Consultant in Plastic Surgery, Walter Reed General Hospital, Washington, D. C.

Discussion of foregoing papers: Ben L. Boynton, M.D., Houston, Texas.

**3:30 Homeostasis of the Surgical Patient and Its Value for Convalescence and Rehabilitation.**

HENRY T. RANDALL, M.D. (by invitation), Assistant Professor of Surgery, College of Physicians and Surgeons, Columbia University, New York, N. Y.

Discussion: Walter J. Lee, M.D., Richmond, Va.

**4:00 Physical Medicine and Rehabilitation in Europe.**

FRANK H. KRUSEN, M.D., Professor of Physical Medicine, Mayo Foundation, and Head of Section on Physical Medicine, Mayo Clinic, Rochester, Minn.

## GENERAL SCIENTIFIC SESSION

### FRIDAY, September 1 — 9:30 A. M.

### Parlor A

OFFICERS OF THE SECTION

Chairman — Frank H. Krusen, Rochester, Minn.
Secretary — Shelby Gamble, Cleveland.

**9:30 Physical Medicine and Rehabilitation: The Problems of Education.**

HOWARD A. RUSK, M.D., Professor and Chairman, Department of Physical Medicine and Rehabilitation, New York University, New York, N. Y.

**9:50 The Influence of Microwaves on the Enzyme Systems in the Eye.**

LOUIS DAILY, JR., M.D. (by invitation), Fellow in Ophthalmology, Mayo Foundation;

E. ALBERT ZELLER, M.D., Ph.D. (by invitation), Research Associate, Mayo Foundation;

KHALIL G. WAKIM, M.D., Ph.D. (by invitation), Professor of Physiology and Research Consultant to the Section on Physical Medicine, Mayo Foundation;

JULIA F. HERRICK, Ph.D. (by invitation), Associate Professor of Experimental Medicine, Institute of Experimental Medicine, Mayo Foundation,

and

WILLIAM L. BENEDICT, M.D. (by invitation), Professor of Ophthalmology, Mayo Foundation, and Head of Section in Ophthalmology, Mayo Clinic, Rochester, Minn.

**10:10 The Effect of Microwave Radiation on the Peripheral Pulse Volume, Digital Skin Temperature and Digital Blood Flow in Man.**

EMERY K. STONER, M.D. (by invitation), Assistant Instructor in Physical Medicine, Department of Physical Medicine and Rehabilitation, Graduate School of Medicine, University of Pennsylvania, Philadelphia, Pa.

**10:30 The Effect of a Short Period of Strenuous Exercise on Hemoconcentration.**

ROBERT C. DARLING, M.D. (by invitation), Associate Professor of Medicine and Coordinator of Physical Medicine and Rehabilitation, College of Physicians and Surgeons, Columbia University,

and

ETHEL SHEA, B.S. (by invitation), Research Assistant, College of Physicians and Surgeons, Columbia University, New York, N. Y.

**10:50 A Dynamic Method for the Measurement of Muscular Force.**

KURT S. LION, Ph.D. (by invitation), Associate Professor of Applied Bio-Physics, Department of Biology, Massachusetts Institute of Technology, Cambridge, Mass.

**11:10 The Influence of Alternate and Reciprocal Exercise on Work Output.**

FRANCES A. HELLEBRANDT, M.D., Professor of Physical Medicine and Director of the Baruch Center of Physical Medicine and Rehabilitation, Medical College of Virginia;

SARA JANE HOUTZ, M.S. (by invitation), Assistant Professor of Physical Therapy, Baruch Center of Physical Medicine and Rehabilitation, Medical College of Virginia,

and

ROBERT N. EURANK (by invitation), Research Assistant, Baruch Center of Physical Medicine and Rehabilitation, Medical College of Virginia, Richmond, Va.

**11:30 Some Observations Regarding Physical Agents in Respiratory Tract Infections.**

J. WAYNE McFARLAND, M.D., Director of Physical Medicine, Washington Sanitarium and Hospital, Washington, D. C.

**11:50 A Method of Rapid Progressive Neuromuscular Re-education.**

A. W. SCHENKER, M.D., Attending Physiatrist, Halloran Veterans Administration Hospital, Staten Island, N. Y.

## GENERAL SCIENTIFIC SESSION

### FRIDAY, September 1 — 9:30 A. M.

### Parlor C

OFFICERS OF THE SECTION

Chairman — ARTHUR L. WATKINS, Boston.
Secretary — EDWARD KREUSEN, Jr., Rochester, Minn.

**9:30 Physical Exercises in Low Back Conditions.**

FRANK R. OBER, M.D. (by invitation), John B. and Buckminster Brown Professor of Orthopedic Surgery, Harvard Medical School, Emeritus, Boston, Mass.

**9:50 Studies on Increased Vasomotor Tone in the Lower Extremities Following Anterior Poliomyelitis.**

FREDERIC J. KOTTKE, M.D., Associate Professor, Division of Physical Medicine, University of Minnesota Hospitals,

and

G. KEITH STILLWELL, M.D. (by invitation), Research Fellow, Sister Elizabeth Kenny Foundation Fellowship Division of Physical Medicine, University of Minnesota Hospitals, Minneapolis, Minn.

**10:10 The Electrophoretic Patterns of Serum and Plasma from Patients with Anterior Poliomyelitis.**

J. J. ROUTH, Ph.D. (by invitation), Associate Professor of Biochemistry, State University of Iowa Medical School,

and

WILLIAM D. PAUL, M.D., Associate Professor of Medicine, Chairman Section on Physical Medicine, State University of Iowa Medical School, Iowa City, Ia.

**10:30 The Use of Dihydro-beta-erythroidine in Early Poliomyelitis.**

WILLIAM D. PAUL, M.D., Associate Professor of Medicine, Chairman Section on Physical Medicine, State University of Iowa Medical School,

and

DONALD C. ZAVALA, M.D. (by invitation), Resident in Internal Medicine, State University of Iowa Medical School, Iowa City, Ia.

**10:50 Problems in the Measurement of Thermal Radiation.**

G. KEITH STILLWELL, M.D. (by invitation), Research Fellow, Sister Elizabeth Kenny Foundation Fellowship Division of Physical Medicine, University of Minnesota Hospitals,

and

ALLAN HEMINGWAY, Ph.D. (by invitation), Professor of Physiology, University of Minnesota Hospitals, Minneapolis, Minn.

**11:10 The Trigger Point Syndrome with a Consideration of Possible Involvement of the Glomus Body-Organ of Non-Tumor Formation and of Unknown Etiology.**

PHILIP R. TROMMER, M.D., Instructor in Medicine, Hospital of the Woman's Medical College, Philadelphia, Pa.

**11:30 The Effects of Prostigmine on Skeletal Muscle in Upper Motor Neuron Lesions: Preliminary Report.**

GERALD G. HIRSCHBERG, M.D., Fellow in Physical Medicine and Rehabilitation, New York University College of Medicine, New York, N. Y.,

and

ARTHUR S. ABRAMSON, M.D., Chief, Physical Medicine Rehabilitation Service, Veterans Administration Hospital, Bronx, N. Y.

**11:50 Status of Physical Medicine Rehabilitation Bed Services in Veterans Administration Hospitals.**

CARL C. HOFFMAN, M.D., Assistant to the Chief, Physical Medicine Rehabilitation Division, Veterans Administration Central Office, Washington, D. C.

## SUPPLEMENT

Papers that follow will be read by title. All papers in this group will be submitted for publication in the ARCHIVES OF PHYSICAL MEDICINE.

**The Value of the Pylon in the Pre-Prosthetic Management of the Lower Extremity Amputee.**

LESLIE BLAU, M.D., Veterans Administration Center, Wadsworth, Kansas;
JOSEPH E. PHILLIPS, B.A. (by invitation), Veterans Administration Center, Wadsworth, Kansas,

and

DONALD L. ROSE, M.D., Associate Professor of Physical Medicine, University of Kansas School of Medicine, Kansas City, Kansas.

**Use of Rocking Bed in Poliomyelitis.**

CLARENCE W. DAIL, M.D., Associate Professor, Department of Therapeutics, College of Medical Evangelists, Los Angeles, Calif.

**Bilateral Compression of the Radial Nerve (Crutch Paralysis).**

LOUIS N. RUDIN, M.D., Chief, Physical Medicine Rehabilitation Service, Veterans Administration Hospital, Fort Howard, Maryland.

**A Study of Structural Abnormalities of Spine and Pelvis.**

MILTON G. SCHMITT, M.D., Director, Chicago Clinic of Physical Medicine, Chicago, Illinois.

**Question of Medical Economics.**

GEORGE D. WILSON, M.D., Asheville, North Carolina

and

ARTHUR M. PRUCE, M.D., Atlanta, Georgia.

## SCIENTIFIC EXHIBITS

**Diagnostic Applications of Electromyography.** ARTHUR S. ABRAMSON, M.D. and GERALD G. HIRSCHBERG, M.D.

**Physics in Medicine.** HOWARD A. CARTER, M.E., Secretary, Council on Physical Medicine and Rehabilitation.

**A Positive Approach to Cerebro-Vascular Accident Management.** LOUIS FELDMAN, M.D.

**Posture Studies. The Human Question Mark.** JAMES R. GARNER, M.D.

**Simon Baruch—Father of Hydrotherapy in America.** FRANCES A. HELLEBRANDT, M.D.

**Newer Methods of Muscle Reeducation Employed in the Rehabilitation of Neuromuscular Disorders.** O. LEONARD HUDDLESTON, M.D.; HERMAN KABAT, M.D., and JEAN VIVINO.

**Researches in Electromyology and Analysis.** H. WORLEY KENDELL, M.D.; ARTHUR A. RODRIQUEZ, M.D.; JAMES L. MURPHY, B.S., and HILARY W. PAVELA, B.S.

**Resistive Exercise in Physical Therapy for Thoracoplasty.** JAMES D. MURPHY, M.D.; BATHURST B. BAGBY, JR., M.D.; FRANK P. ILASI, M.D., and ILA J. AMRHEIN, R.P.T.T.

**Therapeutic Exercise in Pools and Tanks.** NATIONAL FOUNDATION FOR INFANTILE PARALYSIS.

**A Nationwide Program for the Handicapped.** NATIONAL SOCIETY FOR CRIPPLED CHILDREN AND ADULTS.

**Self-Help Devices in Rehabilitation.** HOWARD A. RUSK, M.D.; GEORGE G. DEAVER, M.D., and MURIEL E. ZIMMERMAN, O.T.R.

**Device for Rapid Neuromuscular Reeducation.** A. W. SCHENKER, M.D.

**Body Mechanics—Structural Abnormalities of Spine and Pelvis.** MILTON G. SCHMITT, M.D.

**Basic Physiology of Skeletal Muscle and Its Clinical Applications.** KHALIL G. WAKIM, M.D., Ph.D.; EARL C. ELKINS, M.D., and DONALD J. ERICKSON, M.D.

## TECHNICAL EXHIBITS

### ARCHIVES OF PHYSICAL MEDICINE.

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| Name and Location of School | Medical Director and Technical Director | Entrance Requirements ** | Duration of Course | Time of Admission | Maximum Enrollment | Tuition | Certificate, Diploma, Degree |
|---|---|---|---|---|---|---|---|
| Childrens Hospital, Los Angeles[1] | S. S. Mathews, M.D.<br>Mrs. Sarah S. Rogers | a-b-d | 14 mos. | Sept | 14 | $300 | Cert. or Degree |
| College of Medical Evangelists, Los Angeles[1] | Fred B. Moor, M.D.<br>R. William Berdan | a-b-c | 15 mos. | Sept | 16 | $300 | Cert. or Dipl. |
| University of Southern California, Los Angeles[1, 12] | Charles L. Lowman, M.D.<br>Miss Charlotte W. Anderson | a-b-e<br>c-d-HS | 14 mos.<br>1-4 yrs. | Sept<br>Sept-Feb | 20 | $194<br>$18 per unit | Certificate<br>Cert. & Degree |
| University of California Hospital, San Francisco[1] | Lucile M. Ising, M.D.<br>Mrs. Margery L. Wagner | d | 12 mos. | Sept | 16 | $220[2] | Cert. or Degree |
| Stanford University, Stanford University, Calif.[1] | W. H. Northway, M.D.<br>Miss Lucille Daniels | a-b-d | 12 mos. | Varies | 18 | $620 | Cert. or Degree |
| University of Colorado Medical Center, Denver[1] | Harold Dunken, M.D.<br>Miss Mary Lawrence | a-b-d | 12 mos. | Sept | 12 | $300[2] | Cert. or Degree |
| Northwestern University Medical School, Chicago | Emil D. W. Hauser, M.D.<br>Miss Gertrude Beard | a-b-d | 12 mos. | Oct | 16 | $450 | Certificate |
| State University of Iowa Medical School, Iowa City[1] | W. D. Paul, M.D.<br>Mrs. Olive Farr | e | 12 mos. | Sept | 15 | $200 | Certificate |
| University of Kansas School of Medicine, Kansas City[1] | Donald L. Rose, M.D.<br>Mrs. Ruth G. Monteith | a-b-d | 12 mos. | Feb-Sept | 15 | $ 80[2] | Cert. or Degree |
| Boston-Boston School of Physical Education, Medford, Mass. | Howard Moore, M.D.<br>Miss Constance Greene | H.S. | 4 yrs. | Sept | 15 | $550 | Dipl. & Degree |
| Simmons College, Boston | W. T. Green, M.D.<br>Miss Janet B. Merrill | H.S.-e | 1½-4½ yrs. | Sept | 26 | $550 | Dipl. or Degree |
| Boston University College of Physical Education for Women, Sargent College, Cambridge, Mass. | Kenneth Christoffel, M.D.<br>Miss Adelaide McGarrett | H.S.-e-d | 1-4 yrs. | Sept | 20 | $450 | Cert. or Degree |
| University of Minnesota, Minneapolis[1] | M. E. Knapp, M.D.<br>Miss Ruby M. Green | H.S. | 4 yrs. | Sept | 16 | $580[2] | Degree |
| Mayo Clinic, Rochester, Minn.[1] | Earl C. Elkins, M.D.<br>Miss Helen Belknap | a-e | 12 mos. | Sept | 30 | None | Certificate |
| Washington Univ. School of Medicine[1] | Sedgwick Mead, M.D.<br>Miss Beatrice Schulz | c | 2 yrs. | Sept | 12 | $775[13] | Degree |
| St. Louis University School of Nursing, St. Louis[1] | A. J. Kotkis, M.D.<br>Sister Mary Imelda | H.S. | 4 yrs. | Jan-Sept | 10 | $300 | Degree |
| Albany Hospital, Albany, N. Y. | J. W. Ghormley, M.D.<br>Miss Catherine Graham | a-b-d | 12 mos. | Sept | 6 | $250 | Certificate |
| Columbia University College of Physicians and Surgeons, New York City[1] | William B. Snow, M.D.<br>Miss Floy Pinkerton | a-c-e | 1-2 yrs. | Sept | 50 | $710 | Cert. or Degree |
| New York University School of Education, New York City[1] | George G. Deaver, M.D.<br>Miss Elizabeth Addoms | a[1]-b-d | 12 mos. | Sept | 40 | $600 | Cert. & Degree |
| Duke Hospital, Durham, N. C.[1] | Lenox D. Baker, M.D.<br>Miss Helen Kaiser | a-b-d | 15 mos. | Oct | 12 | $350 | Certificate |
| D. T. Watson School of Physiatrics, Leetsdale, Pa.[1] | Jessie Wright, M.D.<br>Miss Kathryn Kelley | a-b-d | 12 mos. | Oct | 30 | $300 | Diploma |
| Graduate Hospital of the University of Pennsylvania, Philadelphia[1] | George M. Piersol, M.D.<br>Miss Dorothy Baethke | a-b-d | 12 mos. | Sept | 20 | $400 | Certificate |
| University of Texas School of Medicine, Galveston[1] | G. W. N. Eggers, M.D.<br>Miss Ruby Decker | b-d | 12 mos. | Jan | 8 | $163[2] | Certificate |
| Hermann Hospital, Houston[1] | Oscar O. Selke, Jr., M.D.<br>Mary Elizabeth Kolb | a-b-d | 12 mos. | Oct | 12 | $300 | Cert. or Degree |
| Baruch Center of Physical Medicine of the Medical College of Virginia, in affiliation with Richmond Professional Institute, Richmond[1] | Walter J. Lee, M.D.<br>Miss Susanne Hirt | H.S.-a-b-c-d-e | 1-4 yrs. | Sept | 54 | $375[2] | Dipl. or Degree |
| University of Wisconsin Medical School, Madison | Harry Bouman, M.D.<br>Miss Margaret A. Kohli | a-b-c<br>H.S. | 12 mos.<br>4 yrs. | Feb-Sept<br>Sept | 20<br>20 | $120[2]/yr<br>$120[2]/yr | Certificate<br>Cert. & Degree |
| Medical Department — U. S. Army — Medical Field Service School, Brooke Army Medical Center, San Antonio, Texas, and | James E. Tate, Lt. Col., M.C.<br>Agnes P. Snyder, Major, WMSC | h | 12[10] | Nov. | 20 | None | See Below |
| Fitzsimmons General Hospital, Denver, Colorado<br>or | Harold B. Luscombe, Col., M.C.<br>Olena M. Cole, Capt., WMSC | Completion MFSS | 12[10] | June | 10 | None | Certificate |
| Walter Reed General Hospital, Army Medical Center, Washington, D. C. | John H. Kuitert, Colonel, M.C.<br>Barbara Robertson, Capt., WMSC | Completion MFSS | 12[10] | June | 10 | None | Certificate |
| Permanente School of Physical Therapy, Oakland, Calif. | O. Leonard Huddleston, M.D.<br>Miss Dorothy Hoag | a-b-d | 12 mos. | July | 30 | $200 | Certificate |
| Cleveland Clinic Hospital, Cleveland, Ohio | Shelby G. Gamble, M.D.<br>Miss Anna Wetterhuus | a-b-d | 12 mos. | July | 12 | $200 | Diploma |

** Courses are so arranged that any of the entrance requirements will qualify students for training. a — Graduation from accredited school of nursing; b — Graduation from accredited school of physical education; c — Two years of college with science courses; d — Three years of college with science courses; e — Four years of college with science courses. H.S. — High school graduation. h — Baccalaureate degree with major in physical education or the biological sciences.

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1. Male students are admitted.
2. R.N. plus one year college.
3. Nonresidents charged additional fee.
10. 12 months includes training at the Medical Field Service School and Fitzsimons or Walter Reed General Hospitals.
12. Students may transfer into the degree course as the Freshman, Sophomore, Junior or Senior Level. All are held responsible for requirements as listed in curriculum outline. This refers to professional as well as nonprofessional courses.
13. First year—$450. Second year—$325.

# APPROVED SCHOOLS FOR OCCUPATIONAL THERAPISTS

## Council on Medical Education and Hospitals of the American Medical Association

NOTE: The duration of the course is expressed in academic years.

| Name and Location of School | College Affiliation | Duration of Course | Classes Start | Entrance Requirements | Tuition Per Year | Certificate, Diploma | Graduates in 1947 |
|---|---|---|---|---|---|---|---|
| University of Southern California, 923½ 35th Place, Los Angeles | University of Southern California | 2 yrs.<br>5 yrs. | FebSept<br>FebSept | Degree<br>High sch. | $420<br>$450 | Certificate<br>Cert.&B.S. | 22 |
| Mills College, Oakland, Calif. | Mills College | 3 yrs. | FebSept | Degree | $200<br>$550 | Certificate | .... |
| San Jose State College, San Jose, Calif. | San Jose State College | 1½ yrs.<br>3¼ yrs. | Varies<br>Varies | Degree<br>High sch. | $ 21<br>$ 21 | Certificate<br>Degree | 10 |
| University of Illinois College of Medicine, 1853 W. Polk St., Chicago | University of Illinois | 5 yrs. | Feb | High sch. | $152 | B.S. | 14 |
| University of Iowa, Iowa City, Iowa | State University of Iowa, College of Medicine | 5 yrs. | ..... | High sch. | $ 85 | Cert.&Deg | |
| University of Kansas, Lawrence | University of Kansas | 2 yrs.<br>4 yrs. | FebSept<br>FebSept | Degree<br>High sch. | $131<br>$131 | Certificate<br>B.S. | 10 |
| Boston School of Occupational Therapy, 7 Harcourt St., Boston | Tufts College | 2 yrs.<br>5 yrs. | Sept<br>Sept | Degree<br>High sch. | $500<br>$450 | Diploma<br>B.S. | 13 |
| Wayne University, 4841 Cass, Detroit, Mich. | Wayne University, College of Med., Coll. of Liberal Arts, Coll. of Education | 5 yrs. | ..... | High sch. | ..... | ..... | |
| Kalamazoo School of Occupational Therapy, Western Michigan College of Education, Kalamazoo | Western Michigan College of Education | 1½ yrs.<br>4 yrs. | FebSept<br>FebSept | Degree<br>1 yr. coll. | $127<br>$127 | Diploma<br>Degree | 20 |
| Michigan State Normal College, Ypsilanti | University of Michigan | 5 yrs. | Varies | High sch. | $118 | Cert.&Deg. | 8 |
| University of Minnesota, Church Street, Minneapolis | University of Minnesota | 4 yrs. | ..... | High sch. | $360 | B.S. | |
| College of St. Catherine, St. Paul, Minn. | The College of St. Catherine | 3½ yrs. | Varies | 1 yr. coll. | $210 | Degree | 4 |
| Washington University School of Medicine, St. Louis | Washington University | 3 yrs. | Sept | 2 yrs. coll. | $400 | Degree | 10 |
| University of New Hampshire, Durham | Univ. of New Hampshire | 5 yrs. | Sept | High sch. | $160 | Cert.&Deg. | 6 |
| Columbia University College of Physicians and Surgeons, 630 W. 168th St., New York City | Columbia University | 1½ yrs.<br>2½ yrs. | Sept<br>Sept | Degree<br>2 yrs. coll. | $450<br>$450 | Certificate<br>Degree | 28 |
| New York University School of Education, 100 Washington Sq. E., New York City | New York University | 4½ yrs. | FebSept | High sch. | $500 | Cert.&Deg. | 20 |
| Ohio State University, Columbus | Ohio State University | 3 yrs. | Quarterly | High sch. | $105 | Degree | 21 |
| Philadelphia School of Occupational Therapy, 419 S. 19th St., Philadelphia | University of Pennsylvania | 1½ yrs.<br>3 yrs. | Sept<br>Sept | Degree<br>1 yr. coll. | $500<br>$500 | Diploma<br>Diploma | 35 |
| Texas State College for Women, Denton, Tex. | Texas State College for Women | .....<br>5 yrs. | .....<br>FebSept | High sch.<br>High sch. | $600<br>$150 | .....<br>Degree | 13 |
| Richmond Professional Institute, 901 W. Franklin St., Richmond, Va. | Medical College of Virginia | 1¼ yrs.<br>3 yrs. | Sept<br>Sept | Degree<br>1 yr. coll. | $200<br>$200 | Certificate<br>Certificate | 20 |
| College of Puget Sound, Tacoma, Wash. | College of Puget Sound | 3 yrs.<br>5 yrs. | FebSept<br>FebSept | Degree<br>High sch. | $350<br>$300 | Certificate<br>Cert.&Deg. | |
| University of Wisconsin, Madison | University of Wisconsin | 4 yrs. | FebSept | High sch. | $320 | Cert.&Deg. | 8 |
| Milwaukee-Downer College, Dept. of Occupational Therapy, 2512 E. Hartford, Milwaukee | Milwaukee-Downer College | 2½ yrs.<br>4 yrs. | Sept<br>Sept | 1 yr. coll.<br>High sch. | $300<br>$300 | Diploma<br>Dipl.&Deg. | 22 |
| Mount Mary College, 2900 Menomonee River Dr., Milwaukee | | Varies | Sept | Degree | $335 | Certificate | 15 |
| University of Toronto, Dept. of University Extension, Toronto, Ont., Canada | University of Toronto | 5 yrs.<br>3 yrs. | Sept<br>Sept | High sch.<br>1 yr. coll. | $260<br>$222 | B.S.Deg.<br>Diploma | 110 |
| Colorado Agricultural and Mechanical College, Fort Collins, Colorado | | 5 yrs. | Sept | High sch. | ..... | B.S. | |

# PHYSICAL MEDICINE **

**The following services are approved by the Council on Medical Education and Hospitals of the American Medical Association and the American Board of Physical Medicine and Rehabilitation. Residencies in this specialty have been approved without specifying the number of years for which they are accredited. The Board will give appropriate credit for training in these hospitals on an individual basis.**

**Hospitals, 42 Assistant Residencies and Residencies, 55**

| Name of Hospital | Location | Chief of Service | Inpatients Treated | Number of Treatments | Asst. Res. & Residencies Offered # | Beginning of Service (1960) | Beginning Stipend (Month) |
|---|---|---|---|---|---|---|---|
| **United States Army** | | | | | | | |
| Letterman General Hospital★ | San Francisco | A. E. White | 21,861 | 188,112 | 2 | 1/1, 7/1 | n |
| †Fitzsimons General Hospital★ | Denver | H. B. Luscombe | 21,090 | 281,585 | 4 | ..... | n |
| Army Medical Center★ | Washington, D. C. | E. M. Smith | 8,676 | 134,137 | 6 | 7/1 | n |
| **Veterans Administration** | | | | | | | |
| †Veterans Admin. Hospital ‡ | Ft. Logan, Colo. | F. J. Fricke | 4,610 | 58,879 | 1 | ..... | n |
| Veterans Admin. Hospital | Chamblee, Ga. | G. D. Williams | 4,923 | 39,181 | 1 | 7/1 | n |
| Veterans Admin. Hospital | Hines, Ill. | L. B. Newman | 20,052 | 472,950 | 2 | 1/1, 7/1 | n |
| Veterans Admin. Hospital | New Orleans | S. Winokur | 1,107 | 49,816 | 1 | 7/1 | n |
| Veterans Admin. Hospital ‡ | Framingham, Mass. | F. Friedland | 9,000 | 24,000 | 2 | 7/1 | n |
| Veterans Admin. Hospital ‡ | Jefferson Bks., Mo. | S. Mead | 4,046 | 53,920 | 2 | 7/1 | n |
| †Veterans Admin. Hospital ‡ | New York City | K. Harpuder | 12,613 | 279,817 | 3 | 1/1, 7/1 | n |
| Veterans Admin. Hospital ‡ | Cleveland | H. T. Zankel | 2,452 | 105,000 | 2 | 7/1 | n |
| †Veterans Admin. Hospital | Aspinwall, Pa. | S. Machover | 1,993 | 62,792 | 1 | 7/1 | n |
| †Veterans Admin. Hospital | Portland, Ore. | E. W. Fowlks | 4,395 | 98,766 | 1 | 1/1, 7/1 | n |
| **Nonfederal** | | | | | | | |
| Los Angeles County Hospital★‡ | Los Angeles | O. L. Huddleston | ..... | 135,694 | 1 | Varies | $165.00 |
| White Memorial Hospital★ | Los Angeles | F. B. Moor | 33,406 | ..... | ... | ..... | 120.00 |
| Stanford University Hospitals★‡ | San Francisco | W. H. Northway | ..... | 6,833 | ... | 7/1 | 50.00 |
| University of Colorado Medical Center Colorado General Hospital★‡ | Denver | H. I. Dinken | 2,322 | 25,068 | 1 | 7/1 | 75.00 |
| †Emory University Hospital★ | Emory Univ., Ga. | R. La Bennett | 9,848 | 20,266 | 1 | 7/1 | 80.00 |
| †Georgia Warm Springs Foundation | Warm Springs, Ga. | ..... | 589 | 1,108 | 2 | ..... | ..... |
| Cook County Hospital★‡ | Chicago | D. Kobak | 3,357 | 33,262 | ... | 1/1, 7/1 | ..... |
| Michael Reese Hospital★ | Chicago | C. O. Molander | 1,607 | 19,443 | 1 | Varies | 25.00 |
| Northwestern University Medical School | Chicago | ..... | 13,284 | 34,813 | ... | ..... | ..... |
| University of Kansas Medical Center★ | Kansas City, Kan. | D. L. Rose | 11,584 | 31,838 | 1 | 7/1 | 100.00 |
| †Massachusettts General Hospital★ | Boston | ..... | ..... | ..... | ... | ..... | ..... |
| University of Minnesota Hospitals★‡ | Minneapolis | M. Knapp | 15,391 | 21,885 | 4 | ..... | 105.00 |
| Mayo Foundation | Rochester, Minn. | F. H. Krusen | ..... | ..... | 9 | Varies | 92.50 |
| Barnes Hospital★ | St. Louis | ..... | 820 | 10,951 | ... | 7/1 | 25.00 |
| †Bellevue Hospital, Div. III— New York University★ | New York City | ..... | ..... | ..... | ... | ..... | ..... |
| Goldwater Memorial Hospital★‡ | New York City | ..... | 2,799 | 124,357 | ... | ..... | ..... |
| †Hospital for Joint Diseases★‡ | New York City | I. Weiss | 76,070 | 93,036 | 1 | 7/1 | 40.00 |
| Hospital for Special Surgery | New York City | K. G. Hansson | ..... | 41,111 | ... | ..... | ..... |
| Montefiore Hosp., for Chronic Diseases★‡ | New York City | K. Harpuder | ..... | ..... | ... | ..... | ..... |
| Mount Sinai Hospital★ | New York City | W. Bierman | ..... | ..... | ... | 7/1 | 50.00 |
| New York City Hospital★‡ | New York City | F. K. Safford, Jr. | 955 | 26,418 | ... | ..... | ..... |
| †Presbyterian Hospital ★‡ | New York City | W. B. Snow | 70,405 | 191,021 | 2 | 1/1 | 41.66 |
| St. Luke's Hospital★ | New York City | R. Muller | 1,202 | 126,904 | 1 | 7/1 | 80.00 |
| †Rehabilitation Hospital ‡ | W. Haverstraw, N. Y. | M. Hoberman | 322 | 291,115 | 1 | ..... | 200.00 |
| Cleveland Clinic Hospital ‡ | Cleveland | S. G. Gamble | 17,885 | 17,884 | 1 | 7/1 | 135.00 |
| Hospital of the Univ. of Pennsylvania★‡ | Philadelphia | G. M. Piersol | 1,396 | 18,575 | 1 | Varies | 100.00 |
| Philadelphia General Hospital★‡ | Philadelphia | ..... | 3,073 | 21,769 | ... | ..... | ..... |
| Medical College of Virginia, Hosp. Div.★‡ | Richmond, Va. | F. A. Hellebrandt | 3,787 | 34,009 | ... | ..... | ..... |
| State of Wisconsin General Hospital★‡ | Madison, Wis. | H. D. Bouman | 3,783 | 45,846 | ... | ..... | ..... |

The star (★ indicates hospitals approved for training interns.
The dagger (†) indicates temporary approval.
‡ Residencies open to women.
# Includes Fellowships.
n Salary established by government pay tables.
** Reprinted in part J. A. M. A. 142:1195 (April 15) 1950.


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For further information, please write Burnside Larson, Medical Bureau, Palmolive Building, Chicago.

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ANNUAL MEETING

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**Aug. 28, 29, 30, 31, Sept. 1, 1950**

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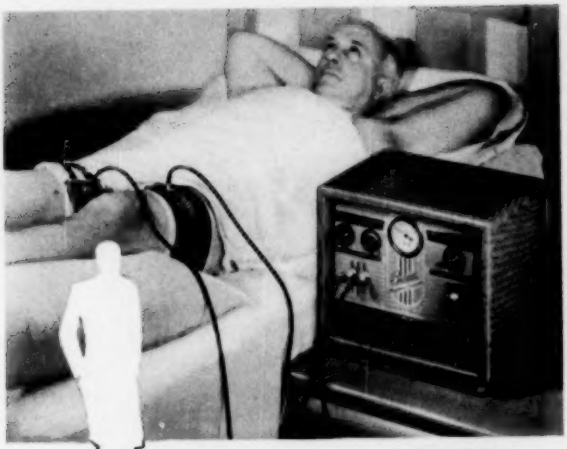

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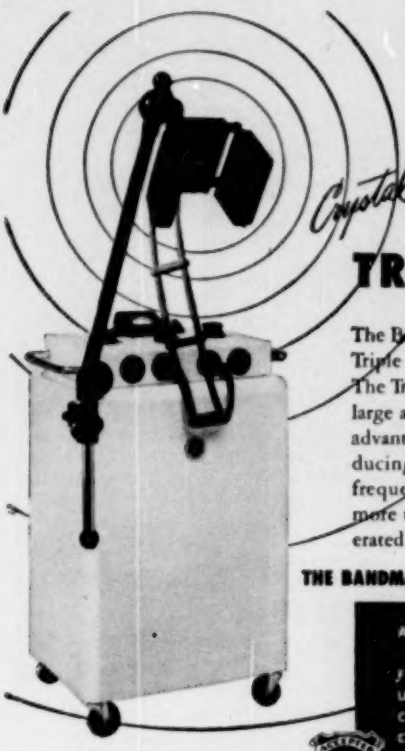

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